Editorial Staff
New York
V. T. Boughton
W. G. Bowman
C. S. Hill
F. W. Herring
H. W. Richardson

Engineering News-Record

A Consolidation of Engineering News, Engineering Record
The Sanitary Engineer, and The Contractor

F. E. SCHMITT, *Editor*

Editorial Staff
Chicago
W. W. De Berard
San Francisco
N. A. Bowers
J. I. Ballard
Willard Chevalier
Publishing Director

Contents for September 22, 1932

VOLUME 109, NUMBER 12

Copyright, 1932, by McGraw-Hill Publishing Company, Inc.

Changing Trends in Waterworks Policy—An Editorial.... 335

Relief Act Encourages Revision in Waterworks Policy..... 336
By MALCOLM E. PIRNIE

Supply and Distribution Works Are Underdeveloped..... 339
By G. GALE DIXON

Safety and Quality of Water Need Improvement..... 341
By F. H. WARING

Waterworks Planning for New Conditions..... 343
By GEORGE W. FULLER

Changes in Waterworks Financing..... 346
By E. B. BLACK

Activities of the Reconstruction Finance Corporation..... 347

Present Status of Waterworks Bonds..... 349

Modern Solutions for Tall Building Elevator Problems..... 350
By CARL F. SCOTT

Understressing and Notch Sensitiveness in Fatigue..... 353
By PROF. J. B. KOMMERS

Editorials.....356 News.....358

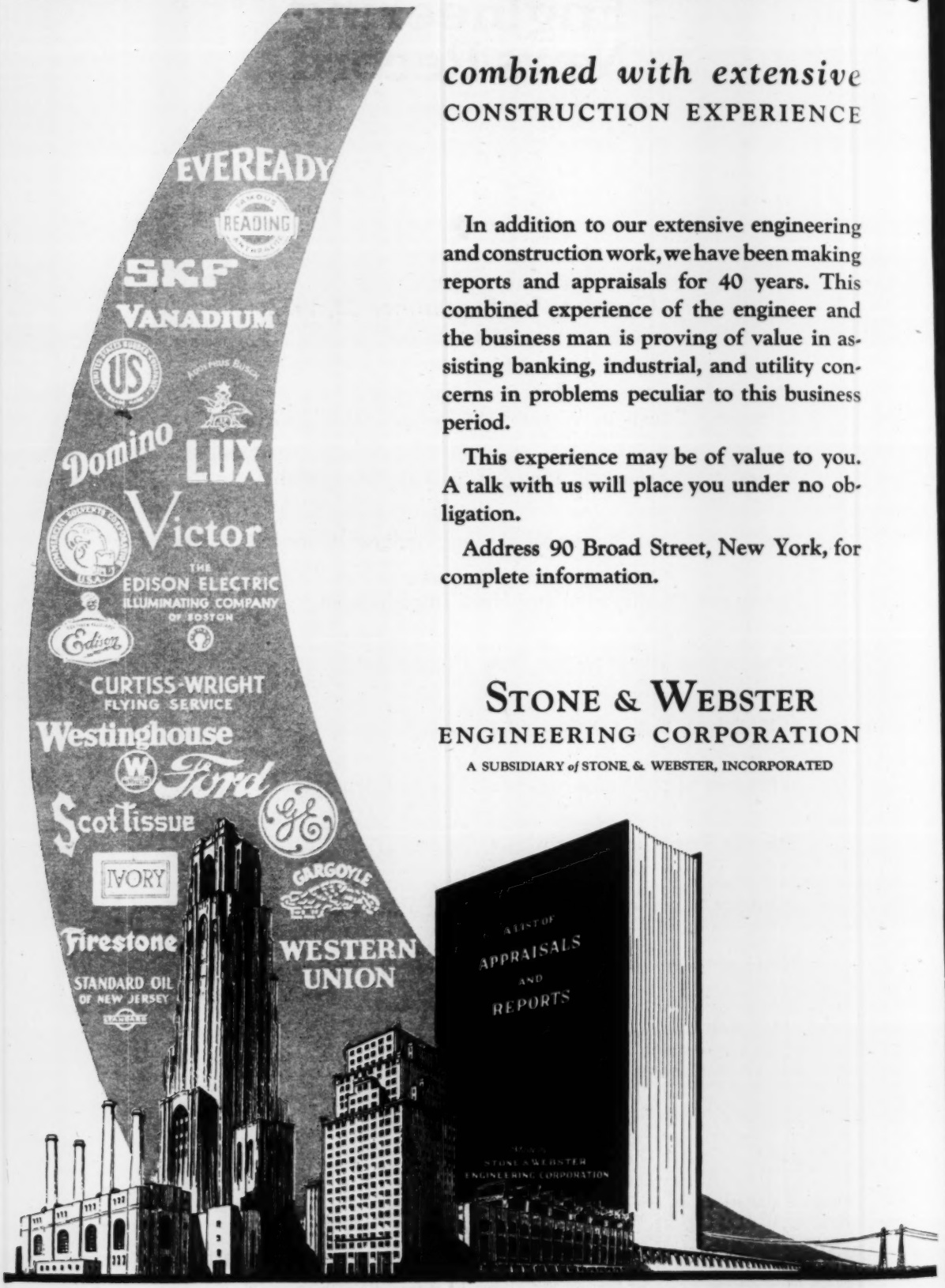
Equipment.....363 Unit Prices.....364

Published every Thursday. Price 25c. per copy. Subscription, domestic, Central and South America, $5 per year. Canada, including duty, $7.50. Foreign $9 or 45 shillings. Entered as second-class matter at the Post Office at New York, N. Y., under the Act of March 3, 1879. Printed in U. S. A. Cable Address "McGRAW-HILL, New York." Member A.B.P. Member A.B.C.

McGRAW-HILL PUBLISHING COMPANY, INC., 330 WEST 42d STREET, NEW YORK, N. Y.

Editorial and Publishing Offices: 330 West 42d St., New York; 520 North Michigan Ave., Chicago; 883 Mission St., San Francisco; Aldwych House, London, W. C. 2, England. Branch Offices: Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Greenville, S. C.; Los Angeles. James H. McGraw, Chairman of the Board; Malcolm Muir, President; James H. McGraw, Jr., Vice-President and Treasurer; Mason Britton, Vice-President; Edgar Kobak, Vice-President; H. C. Parmelee, Vice President and Editorial Director; Harold W. McGraw, Vice-President; C. H. Thompson, Secretary.

REPORTS AND APPRAISALS



combined with extensive CONSTRUCTION EXPERIENCE

In addition to our extensive engineering and construction work, we have been making reports and appraisals for 40 years. This combined experience of the engineer and the business man is proving of value in assisting banking, industrial, and utility concerns in problems peculiar to this business period.

This experience may be of value to you. A talk with us will place you under no obligation.

Address 90 Broad Street, New York, for complete information.

STONE & WEBSTER
ENGINEERING CORPORATION

A SUBSIDIARY *of* STONE & WEBSTER, INCORPORATED

Engineering News-Record

Vol. 109 New York, September 22, 1932 No. 12

Waterworks Policy—An Editorial....335
Waterworks and the Relief Act.....336
More Physical Water Plant Needed...339
Safety and Quality of Water.....341
Planning for New Conditions.....343
Changes in Waterworks Financing....346
Present Status of Waterworks Bonds..347
Policies and Problems of the R.F.C. ..348
Elevators in Tower Buildings—II....350
Understressing in Fatigue.....353
Editorials.....356
News.....358
Equipment.....363
Unit Prices.....364

Changing Trends in Waterworks Policy

A WATERWORKS project, the Los Angeles water supply, has been selected by the Reconstruction Finance Corp. as the first to be granted a construction loan. This action is gratifying to waterworks engineers in its recognition of the claims of waterworks improvement. Also brings into bold relief the realities of the conditions set up for credit eligibility by the R.F.C. administration.

These conditions appear simple, but they involve a radical modification in general waterworks policy, administrative as well as financial. The most significant development in a generation confronts waterworks managements today—a change of municipal water supply from a partly subsidized service to the *business* of supplying water. This issue of ENGINEERING NEWS-RECORD devotes the major share of its space to a discussion of the impact of the self-liquidating features of the relief act upon water supply.

IN THEORY, water service is self-supporting. In practice, it is often not self-supporting, and almost never financially self-liquidating. Outstanding debts are most frequently guaranteed by the taxing power of the community, waterworks revenue is pooled with general city funds, no revenue is received from the community at large for such general service as fire protection and water supplied to public buildings, and expenditure policies are determined by city councils. Rate schedules are not based upon the true cost of rendering service but are dependent largely upon political considerations. Accounting practices are deficient.

All this is due for a profound and far-reaching change, as the articles by Malcolm Pirnie and E. B. Black clearly indicate. Water systems are to become self-supporting in fact as well as in theory. Revenue is to be adjusted to meet all the costs involved in rendering first-class water service as determined by accurate accounting. Extensions and improvements will have to pass the test of economic justification, in so far as such a requirement does not handicap the furtherance of public welfare as affected by the quality of the water supplied. Managements are to be granted a greater degree of autonomy in administering water service and will thereby assume many of the responsibilities now held ultimately by a political body.

ARE IMPROVEMENTS such a vital matter today? An emphatic affirmative answer is given by G. Gale Dixon and Frederick H. Waring in their appraisal of present-day water service. Sources of supply and facilities of distribution in general are not developed to the degree of adequacy required to assure satisfactory pressure conditions at all times. Gratifying though the progress has been in the control of waterborne disease through purification methods, the task of safeguarding the public health does not yet nearly approach completion. A great deal still remains to be done to bring public water supplies to the point of assured satisfaction.

In planning for the future, however, new conditions control, as George W. Fuller admonishes us. A reduced rate of population growth seems certain for the country as a whole, but shifting of population to suburban areas engenders new water supply problems. For economical provision of water service the metropolitan district is a valuable device for these suburban areas and must be given earnest consideration.

ONLY BY TAKING full account of these conditions, and taking account of them promptly, can proposals for waterworks construction be judged as having been planned thoroughly and adequately. The rigid R.F.C. requirements thereby become a stimulus toward sound public service rather than a handicap to immediate construction.

Relief Act Encourages Revision in Waterworks Policy

Self-liquidating requirements will stimulate a change in the method of supporting many public services—Tax rolls will be relieved of numerous items, and individuals benefiting will pay the costs directly in tolls and service charges

By Malcolm E. Pirnie
Consulting Engineer, New York, N. Y.

THE "self-liquidating" features of the Emergency Relief and Construction Act of 1932 necessitate in most instances a realignment of local government practices. The act invites a radical change in local government, perhaps the most radical change in a lifetime, since it specifies what relation must exist between government and citizens before a loan will be made and is not limited merely to prescribing how the money shall be spent. It affects a municipality's financial practices and administration. It requires government to abolish its long-established practice of providing a multitude of its services without charge and to collect their cost from the general tax levy and to set up separate accounts and charges for them before money will be loaned for the construction of needed improvements. In other words, publicly owned utilities must be administered and operated like successful privately owned utilities if the community is to benefit under this section of the act. This mandate for better business management by our local governments may be productive of permanent improvement or may be only temporary in its effect, depending upon whether or not the depression has administered a lasting lesson to the majority of our citizens.

The relief act is most interesting to waterworks management because this municipal service has been provided on a utility basis, at least in theory, for many years. To receive loans, however, many of the characteristics of a successful private utility must be thoroughly embodied in the practices of a municipal waterworks.

Water service is worth more than it costs

Sound business principles dictate that there must be economic justification for each expenditure, in so far as such a policy is consistent with public welfare. But pure water and proper waste disposal are primary necessities of life, and their value cannot be measured in dollars expended in their construction. They are worth more than they cost. In the same way fire protection afforded by adequate water distribution is also worth more than it costs to provide it. With the value of waterworks so much in excess of their cost, all who receive water service should be willing to pay their proportionate share. There is, therefore, in every community that has reason to continue to exist sound economic justification for an ample supply of pure water so distributed as to furnish adequate fire protection. To create such a fortunate and not-too-often-realized condition, there is justification for construction now of needed new or additional water supplies, purification works, pumping stations, main reinforcements and extensions and elevated storage reservoirs. Through the provisions of the relief act, money to build such works is available at low rates of interest to all communities if they will proceed with planning and construction at once and if their systems are on a self-liquidating basis.

To be able to prove that a waterworks is self-liquidating, its planning, management, financing and accounting must be put on a self-contained basis. Data must be made available, showing clearly the actual and complete costs of existing and proposed works, consumption of water, available yield and quality of source of supply, capacity and efficiency of supply and purificaiton works, adequacy of pumps and distribution system to supply the consumers' demands and furnish needed fire protection, rates charged and revenues received from them in the past together with new rates if they are to be changed and estimates of the revenue they may be expected to produce.

To be able to provide data that leads to the conclusion that the system comes within the relief-act eligibility regulations, there must be a management that is competent and clothed with a large degree of independence in planning, operation and freedom in development of personnel. Service to be rendered by new construction and its costs must be carefully and correctly estimated, and charges for service rendered by the system as a whole must produce revenue adequate to pay operating and maintenance costs, interest on indebtedness and provide a sinking fund that will pay all debts as they become due. Such a sinking fund must be inviolate. It must not be subject to diversion to build a golf course or to effect a campaign promise to reduce taxes. A course like this will leave future governments with the problem of refunding the water bonds at their maturity or of raising taxes to pay them off when due, thus damaging the water service.

THE relief act's limitation to self-liquidating public works necessitates a realignment of the practices of local governments in so far as the credit made available is to be utilized. It encourages the setting up of toll gates across many paths in ordinary living that have heretofore been considered free. It affects a city's financial practices and administrative policies. It places government on a utility basis. The change is the most radical in a lifetime, since it relates to the principle of the relation of government to citizen and not merely to methods of operation.

In this development waterworks managements will inevitably be granted a greater degree of autonomy and independence of action. At the same time they will have to assume extra responsibilities. The public service characteristics of water supply, heretofore ultimately the responsibility of the city council, must now become the responsibility of the waterworks management. Independence of authority means independence of responsibility. Management must guarantee adequate fire-protection service to assure the city the lowest insurance rates, and it must maintain the volume and quality of the supply. It, instead of an elected body, is to assume the burden of satisfying the patrons of the system.

Political control leads to insolvent operation

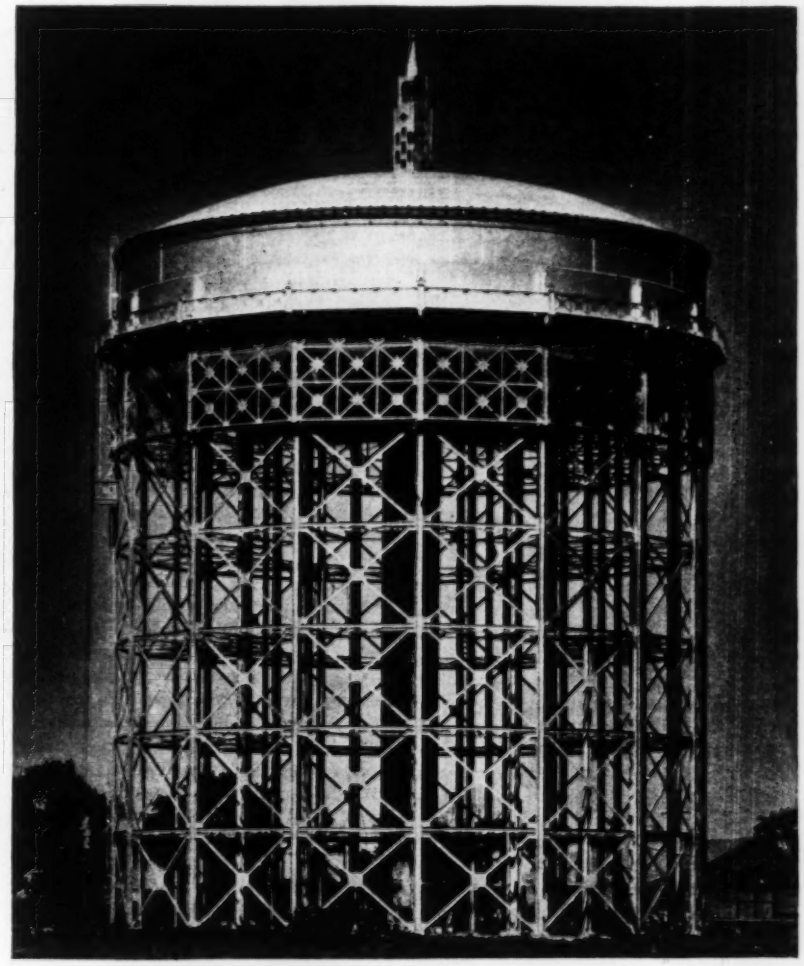
Many waterworks originally self-liquidating have ceased to be so largely because the constantly changing personnel of governments managing them are ignorant of many of the problems that are involved. That has certainly been so in the history of one system with which the writer is familiar. The original system was installed after long discussions had been held among the citizens until there was general recognition of its desirability. In those early days the majority of all voters were owners of real property, and they could not agree to bond their town for the relatively large cost of a waterworks and run the risk of being taxed to pay for it if the project failed. A few venturesome spirits among them, however, organized and built the system as a private enterprise and not many years later were forced to take a substantial loss and reorganize the company, largely because many of the citizens had wives and children who could be sent to their wells for water, and the others served

from the town water system would not consent to an increase in charges however badly it was needed.

As the town grew, new consumers were attached to existing water mains, and the revenues of the water company began to exceed operating costs and capital charges on its reduced debt burden. Speculative real-estate developers then began to demand unprofitable extensions to their sections, and when they were refused they carried their grievances to the people, a large proportion of whom now lived in rented houses and worked in various industrial establishments. Neither they nor the developers intended to own any land in the future, and they readily agreed that the town should own and manage its own waterworks. The company realized that increasing pollution of its source of supply would make capital expenditures necessary for purification works. The cost involved, when added to capital expenditures demanded for unprofitable extensions, would increase the expenses enough to make the business insolvent unless an increase in rates could be secured. The town sold long-term water bonds, bought the water company's property, built a filter plant and extended mains to the developers' properties. Officials then representing the town government announced that an adjustment upward in water rates would be necessary when the filters were ready to operate; but new personnel, when the filters were started, did not raise rates.

Taxes used to pay deficit caused by inadequate charges

Later officials in the town government made up deficits in the operations of the water department out of general tax receipts. No money was available out of revenue to be reinvested each year in reinforcements and betterment of the waterworks to justify refunding of the bonds when they became due. New bonds were issued for all extensions and for new and more distant sources of supply. The water department management and personnel changed almost as often as the personnel of the government until, after the death of one old faithful foreman, no one existed who knew much about the system or was competent to operate it efficiently. Today the value of the entire system is less than the bonds outstanding against it, half of the operating and interest charges are collected from charges for water service, and the other half is paid by the relatively few citizens who own real property and are taxed to pay the deficit in the operations of the water department, without even receiving fire protection sufficient to entitle them to low insurance rates. Furthermore, the outstanding water bonds constitute in fact a lien on all real property in the town, underlying all first mortgages. In these circumstances the credits of enterprises upon which the citizens depend for their livelihood are impaired, and it is sheer folly not to remove such an obstacle to recovery of normal business.



Along with independence of authority of waterworks management will come complete responsibility for the maintenance of satisfactory service conditions at all times. An example of improved conditions is afforded by Evanston, Ill., where a new tank has been installed to provide better pressures.

Tax-secured bonds discourage self-supporting operation

Those who have recently protested most against the so-called cost of government must share responsibility with all other citizens for the development of practices which almost universally support municipal services out of the tax money. Underwriters and purchasers of municipal bonds for all purposes have required that they should constitute mortgages not only upon the works created with the money realized from their sale but also upon all real property in the community. The guarantee that, if the project for which the bonds were issued failed, all other real property in the town was pledged for the loan seemed to make the bonds more attractive to banks and the investing public and lessened the demand for responsible reports upon the economic justification and financial soundness of the project. In these circumstances it was not necessary to make any municipal service self-sustaining. All fell back wholly or in part for support upon the money annually collected from taxes. During prosperous times there was little complaint from owners of real property because they could pass their taxes on to be collected from all the citizens in rent or merchandise. But when unemployment became general and almost everyone ceased buying things he could do without and a large percentage of the rent payers ceased paying rent, taxes could not be passed on, and they became an overwhelming drain and remained as always the first claim upon the vanishing incomes of owners of real property.

It is little wonder that these substantial citizens started war upon taxes. The opening guns devastated the construction business of the country, already lagging behind normal requirements for maintenance, reinforcement and extensions of public services. This had no effect upon taxes except to increase the amount in arrears, but it did have a serious effect upon all business by rapidly increasing the numbers of unemployed who no longer could pay rent or taxes

and who fell back for support upon the community.

Insistance upon self support is the best way to reduce taxes

Out of Washington, however, came a well-timed offer of relief for the innocent casualties of the tax war, which contains unmistakable directions for better aiming of the anti-tax guns in the future. An intelligent distinction must be made between government services rendered to real property and those rendered to the individual. Cost of the former must continue to be met from taxes on property, but costs of the latter can be paid by charges for service as rendered. Why should land pay all costs of traffic regulation, pavement, street lighting and cleaning, waste collection and disposal, sewerage and sewage disposal, parks and playgrounds and substantial parts of the costs of bridges, tunnels, subways, streetcars and waterworks? Chiefly because land with the improvements on it constitutes the security held by government for payment of all services rendered, and also because it is cheaper and requires less government personnel to lump all costs in the tax budget, thus constituting owners of real property as unofficial agents of government to collect taxes from all the citizens in rents and prices charged for things they buy.

It is obvious that many services rendered to individuals of a community cannot be collected economically except indirectly through taxes. But it is equally obvious that other services should be reorganized upon the pattern of public utilities managed and financed as units answerable to, but otherwise independent of, government. Bonds for construction of these units should not be liens on real property in general but should be mortgages on the physical properties and intangibles of the units and should be guaranteed by charges for service sufficient to pay operating and maintenance costs and interest and amortization charges. Among such units might be included pavement and traffic-regulation costs, supported by automobile licenses; highways and connecting roads, supported by a gasoline tax; intercepting sewers and sewage disposal, supported by connection service charges; express highways, long bridges, tunnels, etc., supported by tolls; subways and street railways, supported by fares; and waterworks, supported by equitable charges for service and water consumed.

If the taxpayers and investors in mortgage bonds and municipal securities could comprehend the opportunity to improve government business methods suggested in the "self-liquidating" requirements of the relief act, it would seem that such universal support would be given to initiate immediately all construction needed for extension and betterment of waterworks and sewerage alone that all of the money available for self-liquidating works would be borrowed before the end of the year. Unfortunately, however, there still exists a strong sentiment for return to the "good old days" of low tax rates, when water was drawn from the well and wastes were allowed to remain upon the properties where they originated.

Lowering of living standards will not be permitted

That present health standards would not countenance such regression is not given sufficient weight in the arguments. Adequate value is not assigned to the unprecedented reduction in disease and in the costs of life and fire insurance effected during the last two decades. Our citizens will not countenance a material reduction in present standards of living but are constantly demanding improvements. They want clear, sparkling, colorless water, free from objectionable tastes and odors at all times and are no longer satisfied with the knowledge that the water is safe. They are demanding that pollution be removed from our rivers. They want constantly improved communication over smooth, hard-surfaced roads. They know they can produce more than the country as a whole can consume by working eight hours each day, and they want shorter work days, and parks and playgrounds in which to pass their leisure hours. In these circumstances public services provided by government are bound to increase, and no temporary obstacles placed in the way of construction of public works can reverse the trend. It is possible, however, to improve greatly government business methods, and the greatest benefits to the country will be realized if taxpayers will direct their efforts now to this end.

New Indiana legislation is progressive

Encouraging progress is indicated by the actions of the Indiana legislature in a special session recently concluded. Two enabling acts were passed authorizing cities and towns to establish sewage-treatment works and waterworks on a self-liquidating basis. The sewer service charge and revenue bond act authorizes cities and towns to construct, own, equip, operate, maintain and improve works for the treatment and disposal of sewage; authorizes charges against owners of premises for the use of such works and provides for their collection; authorizes cities and towns to issue revenue bonds payable *solely* from the revenues of such works and makes such bonds exempt from taxation and lawful investments of sinking funds; and further authorizes contracts for the use of such works by other cities, towns and political subdivisions and charges against owners of premises therein served. The act establishing a department of waterworks in cities and towns, as amended, enables cities and towns owning their own waterworks system to create a department of waterworks to be charged with the management and control of such systems, defines its powers and duties and authorizes the issuance of revenue bonds payable *solely* from revenues.

Changing Trends in

There has also been formed the Organization for Promotion of Employment by Public Works in Indiana, of which Governor H. G. Leslie is the head. It is expected that full cooperation will be given by the state board of health in getting under construction immediately the works that are needed to improve health standards in the state, principally construction for adequate sewage disposal and waterworks. It is to be hoped that similar action will be taken in other states, so that unemployment can be reduced and trade recovery stimulated to the full extent possible under the provisions of the relief act for loans on self-liquidating construction. Creation of works of such lasting benefit to the citizens will constitute a worthy monument to the far-sighted wisdom of the legislation embodied in the emergency relief and construction act.

In many states and communities no new legislation is required for the proper business alignment of waterworks. They have been the chief revenue-producing and theoretically self-supporting of all public services. Had past operation and management of waterworks been in strict accordance with the theoretical status, there would be need for no change whatever at the present time. It is now necessary, however, for municipal waterworks to become demonstrably self-supporting by means of adequate revenues, with proper proportioning of revenues to service, including a fair charge against real property for fire protection and collection of current rates for water service supplied for all municipal requirements.

Waterworks managements will be more independent

To regain this theoretically self-supporting status, waterworks managements must be granted a greater degree of autonomy and independence of action than they have enjoyed in recent years, and at the same time they must assume extra responsibilities. The new management should consist of men competent to plan and direct the business of operation, maintenance and extension of this all-important public utility service, which heretofore has been almost universally the direct responsibility of the city council or town board of trustees. Independence of responsibility must go hand in hand with independence of authority, subject only to results. The waterworks management must guarantee adequate fire protection and cooperate with other community activities

Waterworks Policy

and services to assure the city the lowest insurance rates. It must maintain the volume and continuity of the water supply, taking steps to acquire additional sources of supply or additional storage in ample time to avoid a water shortage. It must be on the alert constantly to improve the quality of the water not only as it is supplied to the distribution pipes but also as it is delivered from the services to the consumers. It must regulate and provide for the demands of various consumers in the interests of best service. It must establish rates that are equitable to all water users and must periodically adjust these rates to meet changing conditions of demand and cost of service. In general, it must direct, maintain, enlarge and extend a self-contained business of manufacture and distribution of a product, both wholesale and retail, from the conservation and collection of all the raw material needed, through its transportation and conversion into the finished product to its measured sale in whatever quantities demanded by the ultimate consumers. There is no temptation to overbuild production facilities in such a business and no danger of depletion of existing business from outside competition.

The new waterworks managements must be recruited almost entirely from men with waterworks experience and knowledge. These men for years have justly felt that they did not have authority and independence of action sufficient to allow them to maintain and operate their systems to the best interests of the consumers, and they have often despaired of ever correcting what they knew to be glaring faults in the works or in their business managements. To these men the provisions in the relief act must furnish new hope for real accomplishments in the future.

It must be gratifying also for them to realize that they have been singled out by our national government to stand in the first ranks of all who are fighting to reduce unemployment and stimulate trade recovery. Their qualifications for leadership in the management of waterworks will be demonstrated in so far as they succeed in getting under early construction all needed betterments and extensions to their water supplies, purification works and distribution systems. This is a call not only to local but to national service sent to a loyal and hard-working army of public servants who have too often been taken for granted. They have not struggled and fought to give good service from inadequate plants without gaining ability to seize the present opportunity to make the needed improvements. Many of them are now working for enabling acts and ordinances of state and local governments to allow them to establish self-sustaining systems that will be entitled to loans for the construction work they are planning. Success of any individual in this discharge of a national duty depends upon equal effort and cooperation of a large majority of waterworks men. There is needed construction for waterworks betterments alone to call for half the funds made available for self-liquidating projects by the relief act. What proportion of these funds will the waterworks men use?

Supply and Distribution Facilities Are Underdeveloped

The nature of the water-supply business discourages excess capacity, and system enlargements are usually made only when they can no longer be postponed—Present facilities would be inadequate for demands of normal times

By G. Gale Dixon

Deputy Chief Engineer, Mahoning Valley Sanitary District, Youngstown, Ohio

How satisfactory is present-day water service in the United States? When contrasted with conditions in the days of the town-pump or "old oaken bucket," of course, water service of 1932 seems to approach perfection. But water service is no longer only an individual problem. Public health and fire protection are now fully as important as the convenience of an individual householder. The expert's view is probably more critical than that of the water user, for the expert appreciates fully the handicaps that inadequate physical facilities place in the way of a waterworks' fulfillment of its complete function. In this and the following article water service of today is discussed from two aspects, quantity and quality. —EDITOR.

IMPROVEMENTS in the adequacy of water supply are desirable in nearly every city in the United States. Public water supplies are not subject to overdevelopment like some other businesses, but on the contrary, they are expanded only when the need is so great as to be obvious to all. Supply works in general are inadequate under adverse climatic conditions to meet the demands of normal times. Distribution systems are likely to cover adequately the area to be served, but carrying capacity is deficient.

Public water service is not amenable to that exploitation by way of false markets which has inflated industry and commerce generally to the point of explosion and collapse. Volume of water sales is not readily responsive to high-pressure salesmanship, and the possibilities for geographical expansion of the market for the output of each individual plant are rigidly limited. In consequence, waterworks properties under both public and private ownership are quite generally free from that burden of excessive useless plant capacity under which industry in general now lies prostrate. It is true that many privately owned water utilities have been exploited and that investors have suffered losses through them, but the nature of the industry is such that quick profits for the financial manipulator have been found to lie on the side of undercapacity rather than overcapacity of plant. Wildcat schemes for water-supply projects, sometimes of imposing scale, have come to public notice from time to time, but they have not often been carried beyond the stage of futile propaganda. In publicly controlled water services a progressive development of source and of facilities for the treatment and transmission of the supply have quite commonly been carried on with a sane purpose, foresight and a view to ultimate economy which might well be emulated in other fields of commercial endeavor.

Supply works are of highly permanent nature, are most economically developed in units adequate for considerable periods in the future and involve proportionately larger expenditures than do other parts of the system. The sales resistance encountered in advancing even meritorious projects of this sort is so high that they are seldom undertaken until the necessity for them is immediate and obvious. Of course there are exceptions, and doubtless flagrant ones, but by and large it may be said that the supply works of the public water services of the country are underdeveloped, rather than the reverse, in relation to the demand to be anticipated under truly normal conditions.

Except as to horizontal extent, the same can be said regarding the facilities

for distribution. Premature extensions of distribution mains to provide for unsound real estate ventures have been quite common, but in most instances the cost has been met by some agency other than the water service. Where this has not been the case, the amount of the injudicious expenditure will usually be found to be but a negligible proportion of the total sound investment in the waterworks property.

The greatest need for improving distribution systems is in replacing or reinforcing existing mains rather than in extensions into new territory. This view shows the installation of a reinforcing main in a built-up section of Chicago.

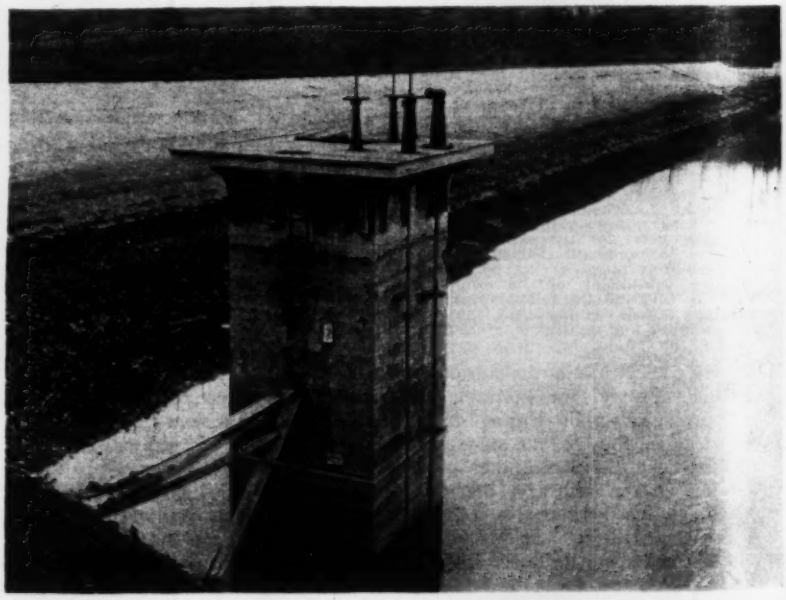
In many cities of small or moderate size it has been common for the distribution system to be allowed to grow in horizontal spread without proper control by competent engineering study. This growth usually continues until a time is reached when pressures begin to suffer under ordinary peak loads to such degree as to cause complaints by consumers, and only then steps are taken to make reinforcements.

A water-distribution system must be designed to perform two radically different functions: it must distribute a great number of small quantities of water under reasonable service pressure to the individual consumers, and it must also be capable of concentrating at any given point the large quantities of water necessary to extinguish important fires. The rule of waiting until the need is obvious—if remedies are promptly applied at that time—works reasonably well in determining the need of improvements in ordinary service; it may lead to results suggestive of criminal negligence when applied to fire service.

Generally speaking, inadequate capacity of source, of purification and pumping works, aqueducts and force mains is of such obvious nature that it promptly forces public attention to corrective measures. It will not be necessary to dig deep to uncover the cases of this class that really need attention. Regarding distribution systems, it is probably safe to say that there is not a city in the country in which improvements of at least minor nature are not desirable and necessary.

Many cities whose supplies were proved to be deficient or dangerously close to that condition during the recent years of drought have already gone forward with further development of the source. Obviously any city that has had such a demonstration of inadequate source and that has not undertaken improvements of reasonable scale

The drought of 1930 showed that many cities had not developed their sources of supply to the point of complete adequacy under adverse conditions. At Bloomington, Ind., the water in the impounding reservoir was so low in February, 1931, that the city was forced to develop hurriedly an emergency groundwater source. Only by drastic conservation measures was water service continued at all.



Changing Trends in

should avail itself immediately of the present opportunity offered by federal credit agencies for favorable sale of bonds. Some such cities have been lulled into a false sense of security by the coincidence of more plentiful rainfall and a subnormal demand for water, but both drought and increased demand will surely return. In other cases political differences have been instrumental in preventing agreement on the selection of a project; surely this is the time for competent engineering study to demonstrate the most advantageous project, and for a united front for its furtherance. In somewhat similar case are some cities in which political considerations have held water rates so unreasonably low as to make impossible the financing of plainly necessary plant enlargements; here again the course of obvious wisdom is to establish an equitable rate structure and proceed promptly with the improvement.

At this stage of the development of the country it is to be presumed that every community has taken steps to make its public water supply safe against the transmission of water-borne disease, but there are still many public supplies of quality far below the standard that present-day enlightenment demands.

The opportunities for sound capital investment looking to the improvement of quality of service will be found to be even more numerous than those for the increasing of quantity of supply. In this category fall projects for improvement of the quality of the supply by treatment; for improvement of normal service pressures and of fire service by judicious reinforcement of the

Waterworks Policy

distribution system, or the construction of service reservoirs or elevated tanks, or both; and the conditioning or duplication of vulnerable vital parts of the system for insurance against failure of service.

Most cities are now facing material reductions in water revenues, resulting not only from slow or lost collections but also from reductions in the use of water. Fortunately the basic nature of the demand for water assures a future resumption of sales volume. The current falling off of revenue in many instances makes the financing of large projects difficult or impossible, but few water services are in such straits that they cannot manage to swing a small volume of highly important improvements.

Many signs now point toward business recovery, and it behooves us all to neglect no single act which good judgment indicates will help to hasten it. There is unquestionably room in the waterworks industry to absorb a significant portion of the capital now made available under the emergency relief and construction act in fundamentally sound improvements, which in different instances will run the whole scale of character and size. In the present emergency it is clearly the duty of the responsible authorities to develop such sound projects to the point of construction without delay; and, no less clearly, to check unhesitatingly the efforts that will surely be made to forward projects of unsound character. That provision of the act which requires that projects must be self-liquidating in character to secure aid in financing appears to guarantee against the danger of overdevelopment. Under present conditions, however, strong pressure will be brought to bear upon public bodies looking to the advancement of construction, with the primary purpose of immediate stimulation of local markets, without regard to ultimate economy; sound engineering advice to the local authorities will be required to counteract such pressure, whether it be political, charitable or selfish, and to accomplish the desired and necessary end through justifiable means.

Safety and Quality of Water Still Need Improvement

Increasing burdens of pollution and structural defects or obsolescence present existing or potential hazards to safety —Higher esthetic quality now demanded by water consumers

By F. H. Waring
Chief Engineer, Ohio Department of Health Columbus, Ohio

IF THERE were now available for every municipality a comprehensive report by competent waterworks engineers, there would be revealed a vast amount of work in the aggregate that needs to be done in the development of the safety of public water supplies and the continued assurance of such safety. Likewise, there would be shown large room for improvement from the standpoint of esthetic satisfaction in the quality of public water supplies delivered to the consumers.

The need for betterment of quality in public water supplies in order to provide more safety to the consumer in drinking water is not always reflected in the typhoid fever death rate of a community. Sanitarians familiar with the principles of the Mills-Reincke phenomenon know that there are many corollary illnesses prevailing in a community with inferior or only a fair quality of drinking water. In recent years, especially in those areas of the country afflicted by prolonged droughts and where polluted surface-water supplies must be depended upon for the public water supply, a conviction has been growing that rather wide-spread illness prevalent in the communities at such times is attributable in some way to the toxic effects of drinking water rendered bacterially safe but being procured from such highly polluted sources. However, whether the water supply is derived from surface or underground sources there do exist at the present time many potential and actual hazards to its safety.

Surveys by Public Health Service

A most valuable and instructive piece of work is undertaken regularly by most of the states in cooperation with the U. S. Public Health Service in the certification of public water supplies for use by interstate carriers for drinking-water purposes. Before such certificates are authorized careful studies of the public water-supply developments are needed to ascertain potential and actual hazards to the public health. Recent surveys of public water supplies in Ohio, probably in common with those of other states, show an amazingly great percentage of municipal waterworks that now need betterments to insure the continued safety of existing water supplies procured from groundwater sources. Annual repetition of these careful surveys, as is required in the certification, reveals strangely that much of the needed work has already been pointed out to waterworks officials and municipal executives in previous surveys.

Some of the deficiencies with respect to the safety and satisfaction of groundwater supplies will be pointed out herewith. The existence of structural defects is not confined to the small waterworks but affects large works as well.

Many wells are poorly located with regard to possible underground contamination. Correcting such a condition may involve an improvement of major character depending upon the results of surveys for new wells, involving the questions of both quality and yield of groundwater. An alternative to the relocation of the well-water supply to avoid dangers of contamination would be the construction of a suitable water-treatment plant for the old supply at or near the old location.

Poor development of supply wells is also common. The correction of this condition may involve the reconstruction of the wells either at the existing site or at a new location or by a major change in the method of pumping, or the remedial improvements may be rather minor in character, such as the provision of filling and grading to protect the wells against flood influences or surface drainage, or the sealing of the tops of the wells in more suitable manner.

It is surprising how many cross-connections exist between public water supplies of good character and private or semi-public water supplies of doubtful or unsafe character. The usual excuse is the desire for fire protection of a property utilizing a supply of water from an independent source. Sanitarians are agreed that the only satisfactory answer to such a menace is its elimination. A campaign to eliminate cross-connections may precipitate the necessity for planning an additional public water supply on a comprehensive scale.

Many groundwater supply systems that exhibit one or more of the structural defects above noted do not have as a definite part of their physical equipment means for providing a factor of safety in the water quality such as chlorination or its equivalent. Installation of chlorination devices should by all means follow the revelation of

Changing Trends in

the existence of such defects, but such installation should be considered as only a temporary expedient to serve while the structural defects are being corrected.

Municipal officials often overlook the hazard to water safety presented by the existence of open-storage reservoirs on the system. To be sure, many of such open reservoirs are in isolated locations subject only to chance bacterial and algal contamination, but nevertheless such chance exists. There is no excuse for taking chances in public water-supply safety, particularly when safety can be assured so easily. Remedial measures involve cleaning, repairing *and* the covering of such open reservoirs.

Esthetic quality needs betterment

The need for improvement in the esthetic quality of the water is apparent in more than half the public groundwater supplies in Ohio. Reference is made particularly to the mineral characteristics of the water, which in recent years have become rather objectionable to the consumers. People are demanding more and more that a public water supply be of clean appearance, pleasing to the taste, free from objectionable odors and relatively free from objectionable hardness.

Iron and managanese cause the water to have a poor physical appearance by reason of the color and turbidity imparted; staining of fixtures results; satisfactory laundering of clothes is prevented. Iron and manganese are probably the most objectionable of the groundwater characteristics needing correction.

Sulphur, present in many groundwaters, imparts objectionable tastes and odors and sometimes accelerates the corrosion of piping and appurtenances.

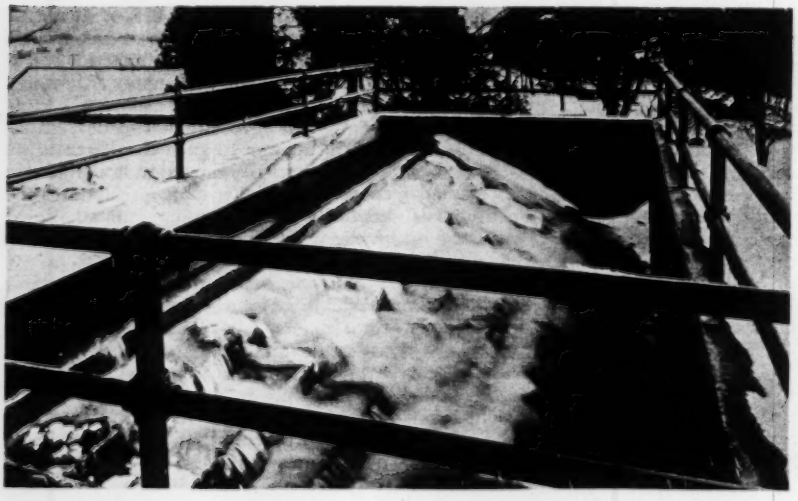
Hardness, resulting from excessive calcium and magnesium constituents, causes great inconvenience to the water consumers; much soap is required at considerable cost to the household, and laundering is made most difficult and unsatisfactory.

To overcome these objectionable mineral characteristics that so commonly impair the esthetic quality of groundwater, there will be required the construction of treatment and removal devices. Iron, manganese and sulphur are rather easily removed by the simple installation of aeration and sand-filtration devices. Hardness constituents will require more elaborate treatment by zeolite or chemical treatment. It is commonly the case that hardness accompanies iron, manganese or sulphur. Therefore, the treatment for the removal of these latter elements will include or accompany, in the majority of instances, the removal of the hardness. A combination of iron or sulphur removal and water softening may be accomplished either by aeration and sand filtration followed by zeolite softening or by aeration and chemical treatment with lime and soda, followed by sand filtration.

Lime softening adds to safety

An important point that most people do not fully understand is the fact that when softened by the lime-soda process water is automatically made sterile. Also the objectionable mineral characteristics are precipitated. Furthermore, such softened water (after recarbonation) cannot be differentiated by taste from natural water of equivalent mineral content. The bactericidal value of the lime-softening process makes this type of treatment particularly suitable for the correction of a groundwater mineral quality problem, especially where groundwater safety is in question. Thus an attractive alternate of reconstructing the groundwater development is offered to that of relocating the supply works to avoid the sanitary hazards of the immediate vicinity of the well system.

Aeration is a simple and effective remedy for many types of objectionable tastes and odors, toward which water consumers are becoming ever more critical. The cascade aerator at Peterboro, Ont., is one type that is in wide use.



Imperfections in surface water

There are also important deficiencies with respect to the safety and satisfaction of surface water supplies. Notwithstanding common knowledge regarding the attendant dangers, there are still a few communities utilizing polluted surface water untreated for public water supplies. Many municipalities, while served with water-purification devices in utilization of contaminated surface waters, nevertheless are served by so old a development that from a structural standpoint certain sanitary hazards now exist. A number of plants have not been provided with the devices necessary to keep pace with the developments in the modern art of water purification. Some sources of supply are now much worse from the standpoint of sanitary quality than when the original water-treatment plant was first installed. Plant equipment and facilities may have deteriorated so that a water of inferior sanitary quality is being produced as compared with former days, and to such an extent that safety of the public health may be endangered. There are a few municipal water-treatment works in good physical condition and utilizing sources of raw water supply that are still fairly good, but which have been operated so as to produce only fair results or results that are not as good as might reasonably be expected of such works. Many officials in responsible charge of water-treatment operations have failed to take cognizance of the increasing popular demand for a brilliant, clear, colorless, tasteless, reasonably soft, finished product from water-treatment plants.

A study of the records at a number of our older purification works serves to indicate that the bacterial pollution load on many existing intakes has been increasing. This statement is not confined to those cities having intakes located in rivers receiving untreated sewage but includes several Great Lakes cities. Remedial measures for such instances may involve the simple expedient of changing the location of the intake. In some instances such a change would necessitate the construction of a new works at a new location. As a rule, changing the location of an intake in a river will not serve materially to correct the increased burden of polution of the raw water. The lessening of the burden caused by untreated sewage will probably require effort and time of agencies outside the jurisdiction of the municipality. There may exist, however, the alternative of

Waterworks Policy

relocating the river intake in a different stream of better natural quality, or the alternative of changing the source of supply by developing an impounding project on a tributary stream not too far away to be within reach of the municipality in question. An outstanding example of putting into practice the foregoing thought is the recent completion of the Meander Creek water-supply project developed by the Mahoning Valley Sanitary District for the cities of Niles and Youngstown, Ohio. These Mahoning River cities have now abandoned the intensely polluted stream for a clean usable source of water supply made entirely safe and satisfactory by modern purification devices. Other cities might well take up at the present time a similar program.

Studies being made of Ohio River

Recently there has been begun a survey of water quality of the Ohio River through the joint agencies of the health departments of Pennsylvania, Ohio, West Virginia, Kentucky, Indiana and the U. S. Public Health Service to determine the trend of water quality in this stream and to set up remedial measures for the benefit of such municipalities that must continue to use this stream for their sources of public water supply. These studies are being conducted under the direction of a subcommittee of the Ohio River board of engineers (the chief engineers of the health departments of the eleven states having area on the Ohio River watershed). The studies will involve much work, and results will not be available for some time. The warning is apparent, however, that on this stream and probably on others of similar nature the time has come for intensive improvement of water-supply sources and water-purification devices, and that more attention must be given to the problem of water supply from streams that must receive sewage and wastes. Experiences during the drought period of 1930 and 1931 in the Ohio River Valley have emphasized the need for concerted action. The concentration of contaminating influences that took place in this river during the drought, causing many tastes and odors and bacterial problems in public water supplies derived therefrom, indicates in some degree what may be expected in future years when increased population and industry may cause similar concentrations in the ordinary low-flow periods of every year.

It would appear that officials responsible for many surface-water-supply developments and treatment works have not taken sufficient advantage of experiences elsewhere in order to utilize the modern advances of the art. For example, an important lesson learned from water-softening experiences may well be taken account of in ordinary water-purification practice; lime-softening, whether needed or not as such, is the most efficient single bacterial weapon in the purification of badly polluted surface water; it is a deterrent for algal troubles; coagulation and clarification become more efficient; it makes possible, temporarily at least, the omission of chlorination, thus avoiding tastes and odors of chlorophenol or other chlorinous compounds resulting from industrial pollution. A few of the many other examples of modern treatment practice that may be incorporated to advantage in existing works of the older type are pre-ammoniation, used as a taste preventer in conjunction with the chlorination process, making possible a better factor of safety in water treatment and the application of activated carbon as an adjunct to the chemical treatment of water supplies afflicted constantly or intermittently with taste ingredients.

The employment of modern practices in older water-treatment plants may require new equipment or the re-arrangement of existing equipment. Plans for expansion of existing works need revision in order to make advantageous use of new treatment practices. It is interesting to note that practically all new plants constructed recently for the treatment of ordinary surface waters provide for water softening in order to satisfy one popular requirement of the present day. The trend of modern practice is toward flexibility of equipment and devices for treatment of the water, in a way not even thought of in the planning of works only a few years ago.

Waterworks Planning for New Conditions

The country's growing population is being distributed differently than in the past—Special administrative districts are desirable for suburban areas—More exacting demands now made on water systems

By George W. Fuller
Consulting Engineer, New York, N. Y.

The most fundamental element entering into the design and operation of a public water system is that of population. Only with a knowledge of the number of people to be served and their territorial distribution, both at present and in the future, can any system be planned properly. The problem is not simple, for the habits of people change. In the following article, Mr. Fuller calls attention to a fact of vital importance in the planning for future water service. Populations are shifting. Further, the demands that consumers make upon water supply are becoming greater. Both of these conditions must be thoroughly understood and appreciated if proper provision is to be made for the future. —EDITOR.

❖ ❖ ❖

REDISTRIBUTION of population in and near large cities, coupled with an improved standard of living conditions, is resulting in new and more exacting demands upon the waterworks industry. Many areas heretofore free of serious public-works problems are now faced with the need for long-term planning and budgeting on a regional basis for waterworks construction projects made necessary by the rapid migration of population from near-by older communities. But planning takes time and money. Before advantage can be taken of the present low construction costs or federal credit provisions, public opinion must be developed to the point where authorization will be given for the necessary preliminary engineering.

It is well to keep clearly in mind that the progress of yesterday frequently becomes the impediment of tomorrow, and that water-supply facilities frequently need to be supplemented or even superseded while still structurally sound, to meet present-day needs as to efficiency and economy.

Public water-supply service in this country shows, like all industries, many discrepancies between theory and practice. An inevitable lag occurs in getting water service actually up to date in all respects. In New York City and in the Metropolitan District of North Jersey it has been frequently observed that ten years is required to get public opinion adequately molded so that organization, administrative and financial steps permit the construction of large projects. Lesser improvements also take substantial periods for authorization. In all cases preliminary steps are needed to authorize preliminary work of an engineering, administrative, legislative and legal nature, without which funds cannot be duly authorized. In particular, the past few years have seen many delays in the carrying forward

of water-supply betterments for our large communities. There have been a number of causes, but among the most important ones are lack of allocation and authoriaztion for water-right acquisitions on streams from which it is proposed to divert new sources of supply, also high construction costs, high financing costs and timidity about expending public funds during a period of depression.

Undoubtedly it is wise now to put waterworks programs and budgets promptly and adequately in shape so that improvements may go forward as soon as practicable in order to take advantage of the present low construction costs, to provide relief for unemployment and to take advantage of the low rates of interest offered by the Reconstruction Finance Corporation. Further, by so doing, trade recovery in a broad sense can be effected.

Water engineers have important duties to perform in this preparatory work, not only as technicians but also as citizens in aiding the formation of sound public opinion. It is of course wise to consider historic viewpoints as to structural, hydraulic and other technical aspects of proposed improvements, but today there are newer aspects to the situation that water engineers must consider most carefully. Historic consciousness is admirable, but under present conditions it is highly dangerous to consider only what has happened in the past.

Population growth is slowing up

One of the most important of these newer aspects relates to changes in population growths. It was only three or four years ago that students of vital statistics estimated that on the basis of possible food production the continental United States might attain a maximum population of 200,000,000 to 300,000,000. Prof. Raymond Pearl estimated that our maximum, to be attained in 2100, would be close to 200,000,000. But recent estimates have been markedly lower. Current views are based on the steadily falling birth rate of our native stock, particularly in the cities, and on the fact that immigration has become less than emigration. The best available present estimates indicate that our country will attain a maximum population of less than 145,000,000 and that this will occur before 1960, unless there should be a substantial change in our immigration laws with an attending influx of peoples with high birth rates. This does not mean that our country is to be less prosperous in the future, but it does mean that we are facing a period of readjustment during which there will be a vast amount of work for the engineer to do in facilitating the adaptation to changed conditions.

Not only has the population of the country as a whole been increasing at a slower rate than before, but a redistribution of population has been going on for some time in our larger centers of population. It is strikingly illustrated by the experiences of Greater New York. The old city, now Manhattan Borough, has less population now than it had in 1910 and about 500,000 less than it had in 1920. While Manhattan has had this growth and recession it is interesting to note the growth from 1910 to 1930 in Brooklyn Borough from 1,634,351 to 2,500,401; in the Bronx from 430,980 to 1,265,258; in Queens from 284,041 to 1,079,129, and in the entire city from 4,766,833 to 6,930,446.

This redistribution of population in New York has left behind many unoccupied tenements in the lower East Side that satisfied the immigrants of earlier days and would probably do so today if there were any such people present. But the children of the immigrants of a generation ago move to the newer houses in other boroughs. This leaves a problem of "slum recovery," which may or may not be worth while, depending upon a variety of local factors. What has occurred so conspicuously in New York has taken place to a greater or less extent in portions of many of the older cities of this country, and it obviously means many new problems for the engineers and managers of waterworks systems.

IT is quite evident from the circular recently issued by the Reconstruction Finance Corporation that all public-works projects proposed for federal loans must already have passed through the stage of preliminary planning before they are eligible for consideration. Not only must the preliminary engineering have been completed, but full financial programs must have been prepared and all necessary legislative steps taken to permit legal action. Preliminary work of this nature involves serious and competent study and also the development of favorable public opinion. Hence, under ordinary circumstances it is invariably slow, frequently requiring a decade or more before construction can begin. The emergency conditions of today demand that that span of time be shortened so that a sufficient volume of work can be authorized, before the public-works powers of the R. F. C. expire, to exert an appreciable effect upon employment. Provisions must be made immediately by local governments to allow the "initial development" of projects to proceed.

Suburban developments present new water problems

Not only is water service affected by the shifting of population within our larger cities, but it is still more affected by the decentralization that has been going on for some years incident to improved roads in suburban and rural areas and to the enormous growth in the use of private and public motor vehicles. This suburbanization is found not only in the vicinity of our very large

Changing Trends in

cities but also near those of relatively small size. Improved transportation facilities have caused the people to go back to the country to live, although not ordinarily to make a living. In New York State from 1920 to 1930 there was an increase in rural population in 49 counties and a decrease in only eight. While this marked change, in comparison with earlier decades, was occurring in rural population, it is to be noted that there was a decrease in the number of farms and of dairy cattle in every county of the state during the same period.

The changes in populations that have recently taken place in urban and rural areas are roughly indicated by census records, as shown in Table I. Further insight into these changes is afforded by a study of the census data on metropolitan districts. A metropolitan district is defined as a region containing a central city having a population of 50,000 or more and where the aggregate population of the district is more than 100,000 by including all contiguous civil divisions having a density of not less than 150 inhabitants per square mile. The growth in such districts during the last decade is indicated by Table II. The data do not include eleven metropolitan districts for which comparable figures are not available. These districts are Chattanooga, Houston, Jacksonville, Los Angeles, Memphis, Miami, New Orleans, Portland, Ore., San Diego, Tampa and St. Petersburg. Were data available from the eleven districts, there would be given still greater indication of the growth of areas adjacent to central cities. The metropolitan areas have been built up rapidly, largely as a result of improved transportation facilities and the desire to secure improved living conditions. An important part of the latter feature is sanitation, which includes not only water supply but also effective sewerage and sewage disposal.

Long-time planning needed

Of course the chief value of the foregoing population data does not lie in their record of past performance so much as in their significance as a criterion of future conditions. Under present abnormal conditions it is essential to study future demands and make plans accordingly, not only along engineering lines but also as to legislation, administration and financing. Effective planning needs due attention along all these lines to set up workable programs and budgets on a long-term basis.

Does the situation outlined above signify that the waterworks industry is a waning one and that the water engineer will have less to do in the future

Waterworks Policy

than in the past? It certainly does not! On the contrary it shows that public water service, broadly considered, must be revamped in many important ways. Revision of many distribution systems is necessary to meet the present and prospective growth, of suburbs, which is replacing the former growth of the older parts of cities. Extensions should be provided for in new areas where growths have recently occurred and are likely to continue as soon as economic conditions justify. In rural districts water service should be provided for as rapidly as arrangements can be made for new plants either in individual villages or preferably, on a district or regional basis. Sources of supply are in some cases unsuitable or inadequate to provide a reasonable margin against future demands. Quality of water needs improvement at many plants, especially as to tastes and odors. Fire-prevention demands are frequently far from what is wise to provide for reducing fire losses and fire premiums, particularly in the widely spread residential suburbs of cities and in the outlying industrial areas that have grown up as a result of population shifts. Wastage of water in distribution systems and by consumers is at many places capable of control to the advantage of all concerned. Inefficient pumping plants should be replaced by modern equipment in the interest of economy. Plant management should be scrutinized to eliminate needless waste.

All of these efforts to adapt public water-supply systems to modern conditions require careful planning, as is emphasized by the regulations set up by the R.F.C. for applicants for credit under Title II of the new relief act. Such planning takes time and involves the expenditure of public funds. The larger communities, in most cases, have made planning for water improvements a continuing function of permanent engineering organizations, but the smaller hamlets and rapidly growing rural areas now without waterworks or opportunities to secure service from neighboring cities are poorly prepared for such a task. It may be helpful to discuss briefly the steps that may be taken by such communities to facilitate their providing themselves with adequate water service.

Political subdivisions of a state as they were originally set up are not always well adapted to promote the installation of various community services, especially water supply, sewerage and facilities for preventing the pollution of water courses. Regional planning for these services has become essential in the great majority of cases, and regional or district projects are particularly pertinent in suburban areas.

Special administrative districts have been very helpful in the past and can be still more so in the future, either for water supply or sewerage and sewage disposal or a combination of all of these services. Of course there are many places where water companies or municipal water departments can take care of areas adjacent to those now served, but there are certain places where a special district set up to provide a specific community service can be of great benefit in making suburban and rural areas more suitable places in which to live.

Such districts have many advantages. Administrative authority is concentrated and responsibility is fixed. Comprehensive planning on a long-term basis is made possible for detached and small centers of population, and progressive installation is facilitated. A continuing policy is assured in line with a definite financial program for putting each designated community service on a self-liquidating basis, supported in each case by adequate self-contained accounting records. Lost motion, delays and misfit planning are lessened. Experience has shown that there is great difficulty in getting small villages and the inhabitants along highways in rural areas to work cooperatively. Public health and welfare are readily provided for in line with modern practice. Methods of financing are, of course, subject to laws that vary in different states, but intrinsically each district or community service can charge all costs of such service equitably to its users. The district procedure has much merit in providing means for many of our citizens to get water and community services in line with the demands of the newer aspects of such service.

A first-class public water supply is one of the most vital community services because of its relation to the health and comfort of our citizens and to the protection of their property against fire losses. Water service ordinarily costs on an average of $2 to $6 per capita per year, or within a usual range of ½c. to 1½c. per person daily. This cost is relatively small, less in many instances than the cost of heat, light, gas, refrigeration, milk or newspapers. Surely first-class water service is worth its cost. Public health is purchasable, and the importance of public water supply is such that its cost cannot justifiably be kept below what is needed to make it safe. There is no excuse for a public supply to have such bad tastes or odors as to lead citizens to resort to waters of uncertain hygienic quality. From another viewpoint, within reasonable limits fire protection afforded by an adequate public water-supply service is relatively cheaper than a supply that is deficient for fire prevention.

Waterworks systems can be improved in economy

Enormous strides have been made during the past generation in improving the economy of water service, but much still remains to be done. For years it has been the belief of many that privately owned water plants are more frugally and efficiently managed than those publicly owned. It is frequently intimated that in some, if not in most, public water departments, as with many sizable business undertakings, there is great room for efficiencies and economies in management. Recently reduced income has brought about enforced economies, some of a type that would be neither wise or necessary in normal times. The writer's experience for more than a dozen years with the efforts of several large street-railway properties to apply more efficient and economical methods of operation to bolster up a waning industry indicates to him that with many water plants also there is opportunity to effect permanent economies such as the transportation industry has had forced on it. Savings versus wastage is a burning theme today. It will be some time before water engineers will have solved the question of how to make a dollar go as far as it is practicable. These comments are not intended as a criticism of waterworks managements but simply as an illustra-

TABLE I — URBAN AND RURAL POPULATION OF THE UNITED STATES

	1910	1920	1930
Cities of more than 8,000 inhabitants	768	924	1,208
Population in millions	35.6	46.3	60.3
Per cent of total population	38.7	43.8	49.1
Places of more than 2,500 inhabitants	2,313	2,787	3,165
Population in millions	42.2	54.3	69.0
Per cent of total population	45.8	51.4	56.2
Total rural population in millions	49.8	51.4	53.8
Per cent of total population	54.2	48.6	43.8
Incorporated places of less than 2,500	11,832	12,857	14,433

TABLE II — TOTAL POPULATION AND INCREASE BETWEEN 1920 AND 1930 FOR METROPOLITAN DISTRICTS

	Population		Increase 1920 to 1930	
	1930	1920	Number	Per Cent
Continental United States	122,775,046	105,710,620	17,064,426	16.1
Metropolitan districts	50,043,223	40,057,307	9,985,916	24.9
In central cities	34,563,274	29,940,288	5,622,986	19.4
Outside central cities	15,479,949	11,117,019	4,362,930	39.2
Outside metropolitan districts	72,731,823	65,653,313	7,078,510	10.8

tion of conditions and results that have characterized the performance of utility services rendered to the public during the past twelve to fifteen years.

As in all business undertakings, it is wise at intervals to take account of stock, both plant and management, to ascertain in what measure, if at all, water service in a community has fallen into a rut and out of line with the betterments of up-to-date practice. And it is highly important now to set up long-term programs and budgets to bring about trade recovery by constructing works at present low prices to meet the needs of shifts in our population and to provide needed improvements in living conditions.

Changes in Financing to Follow Relief Act

Self-liquidating requirements involve payment of capital charges from water revenue instead of from taxation, as in many cases at present—Applications for loans must be based on complete financial study

In theory municipal water systems are self-supporting but in practice many of them fall far short of that condition. The following article is a brief appraisal of the financial conditions most frequently encountered in municipal water departments. Incidentally, the author indicates the reforms in practice that would be necessary if complete self-support is to be attained.
—EDITOR.

By E. B. Black
Consulting Engineer, Kansas City, Mo.

THE Emergency Relief and Construction Act of 1932 places great stress on the proper financial management of municipal and privately owned waterworks systems by stating that a project must be self-liquidating in character to secure a loan from the Reconstruction Finance Corporation, and by defining a self-liquidating project as one that will be self-supporting and financially solvent and able to return the cost of construction within a reasonable period through the payment of tolls, fees, rents or charges other than taxation

Circular No. 3, recently published by the Reconstruction Finance Corporation as an aid to prospective loan applicants, in commenting on the relief act, says in substance that it clearly imposes the requirement that, to be eligible for a loan, a project must be one that will produce sufficient revenue to make it self-supporting without the aid of taxation, and to return its construction cost within a reasonable period. Further, projects requiring loans from the R.F.C. must comply with state laws and the provisions of municipal charters for issuance of bonds. The relief act merely provides a purchaser for the bonds if the project comes within its requirements.

There are cases where such laws or charters conflict with the self-liquidating clause. In such cases it appears that legislation, or a free interpretation of the provisions of the act, will be necessary to make projects eligible for loans. For example, a city water department may be required by its charter to pay all operating expenses, including bond interest, out of water rates, but its sinking fund may be required to be raised by general taxation. A self-liquidating project would certainly be one that earns all interest and sinking-fund requirements itself; and even though rates might be sufficient to satisfy the sinking-fund requirements, charter provisions for that fund to be accumulated by direct tax would have to be changed before the system would be eligible for credit.

Funds for construction of waterworks projects are secured generally by issu-

Changing Trends in

ance of general-obligation bonds of the municipality; or by bonds against the utility instead of the municipality, or water-revenue bonds, secured by the utility and repaid out of operating revenues. Occasionally extensions are financed by water users or by real-estate developers under an arrangement whereby the municipality repays the cost of construction when water sales are sufficient to pay a predetermined return on the investment.

The provisions of this act are probably more favorable to municipally owned than to privately owned waterworks projects. Financing of municipal projects has usually provided for the liquidation of the capital investment in a reasonable period of years, and the rates charged for service are with few exceptions within the control of the municipality. On the other hand, in the operation of the ordinary privately owned waterworks system the investment is not returned to the investor, but the property continues as an operating utility, and its integrity is insured through the payment of rates sufficient to provide for the maintenance, operation, accrued depreciation and return on the investment. Such a system has no control over rates. If, under the requirements of the act, such a project must liquidate the investment in a period of years less than its life, the water user will have paid for the property at the end of such a period, and a condition will have been created for which present practice has never made provision in the setting up of the rate structure.

From a financial standpoint the principal difference between public and privately owned waterworks properties lies in the fact that the former are already by law self-liquidating, while very few of the latter are are self-liquidating in that their revenues from rates are not required or even permitted to be sufficient to retire the capital invested

Charges for water service, to be rationally computed, must be based upon the metered consumption. Wastage is also discouraged thereby, facilitating economical operation. There is illustrated below a multiple test stand for small meters, such as are used for household consumption.

Waterworks Policy

within a period comparable with that in which the investment in municipal plants is retired.

Practically all publicly owned waterworks systems are self-liquidating in that the capital investment is retired in a relatively short period of years, and the water departments are generally solvent to the extent that outstanding obligations are handled promptly. However, this self-liquidation is frequently made possible through taxation, and this method is strictly forbidden by the act in question.

Compliance with the stipulation that the project shall be self-liquidating through rates and not through taxation will mean a general overhauling of the rate structure in a majority of publicly owned waterworks systems, with the probable result that the rates will approximate those necessarily collected by a privately owned system if operating under similar physical conditions. Accounting practices to be followed will have to show in detail the complete operating story of the project. Free water supplied other city departments for fire protection, sewer flushing, street sprinkling, supplying public buildings and other similar uses not now directly charged to the user will have to be paid for in rates collected for such service; funds contributed by water departments to other city departments will have to be held under the control of the water department for its own use.

It has been the general practice of municipal waterworks departments to make ordinary extensions of mains, and sometimes to finance major improvements from rates, the interest and sinking fund requirements being met through taxation. Such procedure appears to be necessary because of the difficulty of getting new capital at the time when it is needed through bonds voted by the municipality. While the conditions surrounding each case require analysis, rates fixed under the relief act should make reasonable allowance for such construction, in the absence of state laws or charter provisions to the contrary. In theory this procedure may not be sound, but in practice it is not always safe to leave the decision on the extension of a water system to the judgment of the voters, and the necessity of providing at times for waterworks construction by the issuance of bonds without a vote is recognized by the laws of several states.

The procedure necessary to be followed in making applications for loans under this act is fully outlined in the circular put out by the R.F.C., and the suggestion is made therein that if there is any doubt as to whether revenues of a given project may not be considered as being derived through taxation, as in the case of assessments made in proportion to the use of facilities afforded by the project, that the applicant furnish proof to the contrary before the preparation of formal application or the data necessary to accompany the application.

Formal applications for loans are required to be accompanied by much general and detailed data of an engineering and accounting nature not ordinarily available in the average water department office. Plans, specifications, reports and estimates by engineers, architects, appraisers and other experts must accompany the application. Full statements are required of plans for financing the project to completion, including a statement of efforts previously made to finance it. Estimates of revenues, rate schedules and detailed estimates of operating costs, interest and sinking-fund requirements must be supplied, in addition to credit information covering the operations of the municipal applicant for the three fiscal years preceding the filing of the application, and for as much as possible of the fiscal year in which the application is made.

The studies of waterworks departments that are necessary in the preparation of data to accompany applications for loans are certain to result in economies of operation and the placing of the departments on a business basis. To this end the data and studies required by the act are necessary and reasonable.

Officials of municipal waterworks departments will no doubt be impressed by the stress the act places on the necessity of operating such departments wholly on revenues from service. To the thinking official, even to one not interested in securing a loan, this will probably suggest the idea that if business methods are recognized as necessary for financing, constructing and operating a waterworks project during a depression, perhaps it would be good business to operate at all times and under all conditions on a similar basis of business efficiency.

The Investor's View of Waterworks Bonds

Municipal water bonds are highly esteemed by the prudent investor—He appreciates their self-supporting features but prefers them to have the added backing of the general credit of the city

THE following article was prepared from information obtained in interviews with specialists in the field of waterworks securities in New York City. Among those whose cooperation is hereby gratefully acknowledged are R. E. Swart, president of Swart-Brent Engineering Co., specialists in water bonds and H. H. Sears, legal editor of *The Bond Buyer*.—EDITOR.

THE STABILITY of earnings enjoyed by the waterworks business puts water bonds in an enviable position. Purchasers, who are largely of the true investor type, recognize the self-supporting character of city water departments and favor water bonds over those issued for general municipal purposes. Water company bonds, for technical market reasons, do not command as high a price as they deserve, but are much sought after by well informed investors, especially insurance companies.

It is generally recognized that interest and sinking-fund requirements of municipal water bonds are most usually met out of water revenue, as is witnessed by the fact that water department debt is not considered as adding to a city's outstanding tax-supported indebtedness. In other words, water bonds are considered self-supporting. For that reason the investor favors them over general municipal securities. He reasons that water rates can be more readily adjusted than tax rates could be to meet bond requirements and he observes that water department revenues are inclined to be more stable than revenues from general taxation. He has noticed furthermore, that few defaults have been reported where payment is primarily dependent on water revenue. The school-district bond is the only type of municipal security with a better record in this respect, largely because of the greater ease with which state or county charges can be collected.

Accordingly, the bond buyer is willing to bid a higher price for water bonds than he is for general municipal bonds—under normal conditions. But when a city falls on evil days in its general financing its water department securities are likely to suffer also. The buyer in this case assumes that a shaky financial position is indicative of incompetent municipal administration and that water department administration is likely to prove correspondingly faulty. He is not a discriminating individual in times of stress.

Although water bonds are considered

self-supporting out of water revenue, in most cases the general faith and credit of the city is pledged as an added guarantee of the payment of the bond requirements. Legally, the usual water bond is merely a general obligation bond carrying a provision that interest and sinking fund requirements are a charge on water revenues. In the event of a default and a subsequent judgment in favor of the bondholders, bonds of this nature issued for waterworks purposes have no priority over other bonds.

Bonds secured by water revenue only are uncommon except where the city's charter expressly authorizes it to operate as a public utility. Cities in the South and West frequently have this charter authority but in the older states of the East it must be conferred in individual cases by legislative action. Bonds of this type carry a trust indenture with sinking fund provisions and the right of the holders to have a receiver appointed by the court to operate the property as a public utility.

An anomalous condition is apparent in water revenue bonds. Because of the proved inability of holders of tax-secured bonds to realize on the security by forced sale of property to satisfy delinquent taxes in time of depression, revenue bonds are really the better investment. Nevertheless the average bond buyer continues to favor tax-secured bonds. The bond house realizes that the explanations that must be made to prospective purchasers make the sale of the securities difficult. As a result, the underwriting of issues of so-called "special-lien" bonds is not handled readily and often involves a large discount.

Segregation of funds of the water department from those of the general municipal treasury is very desirable, but it is uncertain that the water revenues can legally be made inviolate and safe from diversion for general municipal purposes without special provision for it. When surplus revenue of a municipal water department, which had been considered safe from diversion, is taken by the city government for general city purposes in its time of financial stress the effect is naturally highly injurious to the water bonds. To prevent such occurrences it would be necessary for the city government to provide that the water revenues should constitute a trust fund, to be deposited as such in a local bank. Separate incorporation of the water department, with ownership by the municipality, might also solve the question of diversion.

Municipal water bonds bring a much better price than do bonds of private water companies. A large part of the preference can be explained by the tax-exemption features of municipal securities. Further, the lower overhead expense involved in the operation of a municipal utility results in a better earnings position. Under ordinary economic conditions a good municipal water bond will carry a yield in the neighborhood of 4 per cent, while a corresponding water company bond will yield about 5 to 5½ per cent.

Water company bonds made a splendid record during the recent slump in the bond market. During prosperous times average bonds of this character sell at a price yielding between 5 and 5½ per cent return. When business in general began to decline in 1930 water company revenue continued to hold steady and bond prices did not fall. It was not until July, 1931, that water company bond prices broke. The lowest point was reached in January, 1932, when high grade bonds were yielding 6.8 per cent. At the same time middle- and low-grade bonds had an average yield of 8.4 per cent. The prices brought by general utility bonds of a corresponding grade was about 8.3-per cent basis.

The slightly higher price brought by electric utility bonds at that time is characteristic of conditions in normal times as well. It can be explained only by technical bond-market conditions. Water bonds are not issued in large amounts and are not listed on the large exchanges. Insurance companies apparently have a high opinion of this type of security and purchase more of them than anyone else. The usual purchaser of water bonds is not of the speculative type and has a tendency to retain possession of his purchase indefinitely. Accordingly, there is not a large floating supply and liquidity suffers accordingly. It is significant that today there are many more opportunities for selling water bonds than there are of buying them. If it were not for the narrow market conditions they would undoubtedly be priced more favorably than the corresponding grade of general utility bond.

Getting Work Started Through the R.F.C.

Eight weeks' experience in administering the 1½-billion dollar public-works loan provisions of the Emergency Relief and Construction Act, and some of its problems

By Paul Wooton
Washington Representative of Engineering News-Record

EIGHT-WEEKS have passed since the President signed the Emergency Relief and Construction Act of 1932. What is the R.F.C. doing to put the construction fund to work?

In an interview with Harvey C. Couch, director of the corporation in immediate charge of construction loans, Paul Wooton reports the main features of the present work of the R.F.C. and some of the difficulties which complicate it. The outstanding fact of the interview is the conclusion that more active and complete cooperation by local authorities will hasten the creation of employment by the grant of construction loans. —EDITOR.

COOPERATION of local interests is absolutely necessary if the Reconstruction Finance Corp. is to put to use the maximum amount of the $1,500,000,000 fund provided for self-liquidating public-works projects by the Emergency Relief and Construction Act of 1932. Preliminary study of the several hundred projects that have been filed with the Corporation indicates that a substantial proportion of them will have to be rejected. Officials of the Corporation are more than anxious to put the money to work but, it is explained by Harvey C. Couch, the director in immediate charge of the engineering phases of the Corporation's work, great care must be exercised so that none of the taxpayers' money is wasted.

To comply with the law each project must be sound and capable of repaying its cost in a reasonable period. Far too few projects that square with the requirements have been submitted. This is particularly true when all the dead horses that have been hawked from bank to bank and from bond house to bond house for a decade are deducted.

It is manifestly impracticable for the Corporation to go about the country soliciting projects, Mr. Couch points out. In which state would the quest for projects start? Would the public want to pay for the great organization that it would be necessary to set up for that work? Mr. Couch believes it is quite apparent that state and municipal officials, business men, bankers and others must get behind any sound, self-liquidating project with which they are familiar and override any and all obstacles so that a thoroughly prepared application may be placed in the hands of the Corporation at the earliest possible time.

Adequate facts lacking

"Every one of the several hundred applications that have been submitted," Mr. Couch states, "has been gone over carefully and sympathetically by the distinguished men who comprise the board that advises the directors on engineering matters. Only a few of all the

applications submitted were accompanied by adequate facts and engineering data."

"Where there is any indication that the proposed project comes within the act, it is a matter of fixed policy to urge the applicants to alter their plans so as to bring them within the scope of the law or so as to make them more acceptable. The objective of the directors of the Corporation is to help the states meet their relief problems, to create employment and to stimulate business. They are just as anxious as is anyone to get work started. They have worked untiringly to that end. They have had the benefit of the assistance of a highly capable staff. Consideration of self-liquidating projects has been diligent. The reason why more of them have not been approved is not the fault of the Corporation. It has been necessary to await the securing of absolutely essential data, to wrestle with legal problems or to suspend decisions until contracts are worked out."

Waterworks in the lead

Outside of a few large projects such as the Metropolitan Water District of Southern California, the San Francisco bay bridge, the bridge over the Mississippi River at New Orleans, the Midtown Hudson River tunnel and the Triborough bridge in New York, water distribution projects promise to furnish the more immediate outlets for job-making funds. There are twice as many waterworks applications before the Corporation as for any other kind of project.

Mr. Couch calls attention to the fact that applications need not be for new projects. Extensions to the existing water systems for instance, come within the act, provided the receipts from the whole project are sufficient to liquidate the extensions. In the same way an improvement such as the substitution of larger mains may be financed by the Corporation.

Another factor which the Corporation must weigh in each case, Mr. Couch asserts, is the effect of the proposed project on existing facilities. For instance, it will be necessary to ascertain what effect the New York tunnel might have on the George Washington bridge. It is not the intention of the Corporation to disrupt a going concern that is providing reasonable service.

After waterworks, applications covering bridge projects are the most numerous. It is apparent, however, that the number of bridges that can be liquidated in a reasonable time by tolls is more limited than at first would seem probable.

Slum clearance important

Slum clearance, in Mr. Couch's opinion, offers a very promising outlet for relief act funds. For social reasons and because of the amount of employment involved, he is particularly anxious to support such projects, but he points out that the difficulties in making an early start on that type of project are numerous.

Applications have come in for a score or more of irrigation and drainage projects but the sympathetic preliminary examination which each one of these projects has received indicates that there is grave doubt as to the likelihood of some of them being operated at a profit.

Small projects and local action

It is apparent that the Corporation must rely to a very great extent on a large aggregate of relatively small projects. Local officials and public-spirited citizens can cooperate in the most effective way by taking this opportunity to launch these activities. To do this, they should not hesitate to ask the Corporation for preliminary assurance as to the possibilities of the project.

Once that it is known that the project comes within the scope of the law, no time or expense should be spared in preparing the application thoroughly. The supporting data should be worked out just as carefully as would be the case were the project to be submitted to the most conservative banker. The foregoing sketches the thoughts that are uppermost in Mr. Couch's mind on these phases of the Corporation's work.

Many unsolved questions remain

Due to its limited experience there are a number of uncertainties surrounding the authority of the Corporation. One of these is whether or not an assessment constitutes a tax. Under the act "a project shall be deemed to be self-liquidating if such project will be made self-supporting and financially solvent and if the construction cost thereof will be returned within a reasonable period by means of tolls, fees, rents or other charges, or by such other means (other than by taxation) as may be prescribed by the statutes which provide for the project." Since revenue obtained from taxation may not be used to repay a self-liquidating loan, the question arises as to whether an assessment imposed by law constitutes a tax. On this point the legal division has not ruled as yet, but it is apparent that there are a variety of types of assessment.

The question has been raised as to whether or not the gasoline tax constitutes taxation in the sense that that word is used in the law. That matter also is being studied by the legal specialists, although no applications covering road projects have been filed with the Corporation.

Mr. Couch emphasizes that it is not the intention of the Corporation to check every point made in the reports of engineers of recognized standing. The Corporation will not go into detail. It simply will satisfy itself that the project is sound and that it complies with the many requirements of the relief act. It was with the very thought of avoiding detailed scrutiny that Circular 3, the Corporation's publication acquainting prospective applicants with the requirements that must be met, suggests that information be furnished as to prior attempts to finance the project and that the names of those who object to it be furnished. If the character of the objection is understood, it frequently facilitates a decision, Mr. Couch is convinced. It is one of the best ways to avoid looking under every chip to see if there is a bug, he believes. This does not mean that the objectors will be given a hearing, although public agencies must be more liberal in that respect than are private agencies.

No fixed interest rates

Interest rates involve many considerations, and no fixed policy has been adopted by the directors. It is Mr. Couch's personal opinion that interest rates must bear some relationship to the individual project. He points out that interest rates vary when the money is borrowed from private sources.

It is not necessary, Mr. Couch explains, that a project earn its full interest and amortization immediately upon its completion. There again the requirements would depend on the individual case, but the Corporation can be relied upon, Mr. Couch asserts, to be reasonable and practical in making such a decision.

Employment the first consideration

It is the policy of the Corporation to give priority to projects that will create the larger amount of employment. It is recognized that a large proportion of construction money finds its way, directly or indirectly, into wages but, at the same time, the project calling for a large amount of trenching might give immediate employment to many men, whereas the expenditure on another project might be confined more largely to materials already available. In the latter case a much smaller amount of employment would result.

Another limiting factor is the provision in the law that projects must be devoted to public use. Many applications have been received that would be self-liquidating but which are not susceptible to public use.

When it is considered, says Mr. Couch, that the Reconstruction Finance Corporation has been built from the ground up within the calendar year, its record in the handling of applications does not deserve all of the censure it is receiving. It is not unusual, he says, for long established banking institutions to spend many months in the studying of projects for which large loans are sought. In the case of the Reconstruction Finance Corporation the lender is eager and anxious to make the loan, but it is becoming increasingly apparent that *the active cooperation of local interests is essential* if loans are to be made promptly and in large volume.

Modern Solutions of the High-Rise Elevator Problem

Extending a preceding discussion of the modern elevator problem for super-skyscrapers, several possibilities of larger-capacity elevator equipment are described—Double-deck and dual elevators compared, the plaza-floor and express-elevator system and continuous elevators

By Carl F. Scott
New York, N. Y.

AN EARLIER article (*ENR*, Sept. 15, 1932, p. 317) set forth the difficulties of the elevator problem of the tower building or super-skyscraper, where the demands of proper speed and capacity tend to use up so much floor space as to make the whole building uneconomical. The limitations of traffic-handling capacity of single elevator shafts operated in the conventional manner were presented, and brief mention was made of the dual elevator (two elevators in one shaft) and the double-deck elevator. A short description was given of Sixty Wall Tower in New York, where eight double-deck elevators have been installed. The present article treats of the dual and double-deck elevators in more detail and indicates certain other possible solutions of the problem.

The double-deck elevator

Considering first the double-deck elevator, this is merely a large-capacity elevator with its passengers carried in two compartments, one above the other. The cars in Sixty Wall Tower, for example, have a rating for each compartment of 2,500 lb., or 16 persons; this is a total of 5,000 lb. There are numerous installations of 5,000-lb. elevators in department stores and the like, although none have hitherto been run at so high a speed as 1,000 ft. per minute. But this merely means correspondingly larger power for the hoisting motor and its generator set and control, and more powerful brakes and safeties. The hoisting motors for the double-deck elevators in Sixty Wall Tower are rated at 116 hp., which is only a little larger than the motors installed in the high-rise cars in the Empire State Building, where the elevators are rated 3,500 lb. at 1,200 ft. per minute.

The double-deck elevator has two separate cabs mounted in a single frame or sling. The top and bottom cross-head members of this sling are each provided with rail-clamp safeties. In distinction herefrom, the dual elevator, as described below, has two independent cars, one above the other, and two hoisting motors over each shaft, with a roping arrangement that permits the two cars to operate independently on the same guide-rails.

As the Passenger Sees It—To the passenger entering the double-deck elevator the appearance of either compartment is identical with that of a conventional car, and there is nothing to tell him that he is in a double-deck elevator except the following:

(*a*) There are of necessity two loading levels, the main floor and the basement. Passengers for the odd-numbered floors must go to one level, and those for the even-numbered floors to the other level. Two loading levels are an essential feature of either double-deck or dual elevators, to be planned for in the building layout. It would be possible to have some of the cars stop with the top deck at the odd floors and the others with the top deck at the even floors. This would make it possible for a passenger for any floor to use either loading level, but at the expense of twice as long an average interval.

(*b*) The passenger will sometimes notice that the car has stopped without the doors at his compartment opening, as the doors open only when a stop signal has been given for that floor. But if he comes to the door in the hallway and the car is there, but the door not open because the stop was for the adjacent floor, the door will open as

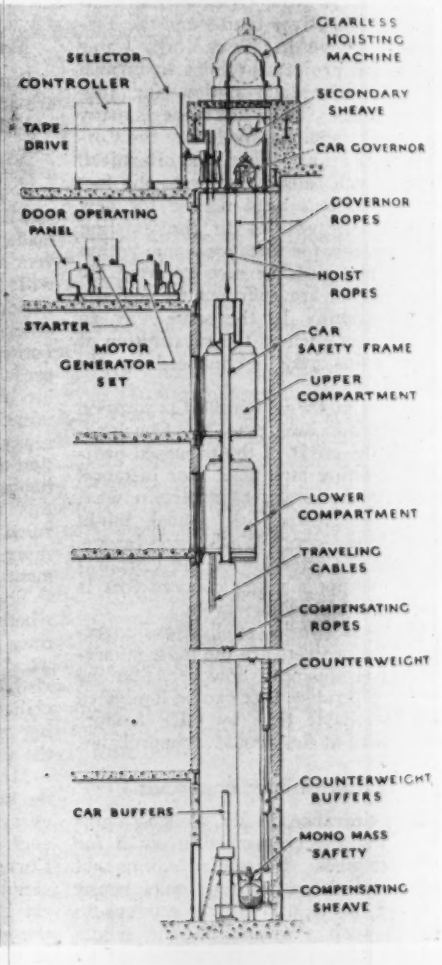


Fig. 1—Double-deck elevator construction. (Otis Elevator Co.)

soon as he presses the button, if the car is going in his direction. Furthermore he will notice that sometimes there is a brief wait after the door of his compartment closes, before the car starts, as the other compartment may not have fully loaded; the two sets of doors are interlocked.

(*c*) During rush hours a passenger bound on some inter-floor errand may expect to walk up or down one flight 50 per cent of the time. During off-peak periods, when there is more inter-floor traffic, the cars in Sixty Wall Tower are to run as single-deck elevators to serve all floors. The cars were not operated as double deck at first as the traffic was still light, but it was planned to run them double-deck even before the tower filled up, so as to get the passengers accustomed to the system.

The dual elevator

Where two elevators are run in one shaft, there are two separate hoisting motors, each with its own generator set and control. The hoist ropes for the lower car pass outside the upper car, between the car frame and the hoistway wall. The hoist motor for the lower car is mounted above the other and has two sheaves, one at each end of the extended motor shaft, so as to span the width of the hoistway, each sheave taking one half the total number of hoist ropes. The counterweight for the lower car is above that for the upper car. Both cars run in the same rails, as do both counterweights.

Aside from the obvious departures from standard practice necessary to get the two cars with their hoist, counterweight and cable-compensating elements in the same hoistway, the important element of the dual elevator arises from the fact that each car is a terminal, so to speak, for the other, in one direction of travel, and provision must be made to prevent the possibility of their colliding. This is done both electrically and mechanically.

The regular control, functioning on every stop, and hence always maintained in order, automatically stops a car that approaches the other nearer than a fixed distance. The car so controlled stops at the nearest floor level and not between floors. In addition, a mechanical differential arrangement between the two driving motors causes the main overspeed governor to change its setting so that it will trip at a lower speed when the cars approach each other too closely. The counterweight for the lower car, which is above the counterweight for the upper car, carries an oil buffer, and this buffer will come in contact with the counterweight for the upper car before the cars themselves can touch and will prevent them touching at all if the other safety provisions fail.

The dual system allows no option of the two loading levels. The passenger must choose the right one. This is no handicap as compared with the double-deck elevator, as the efficient operation of the latter does not permit of choice of level for a given floor, except that such choice may be had at the expense of walking up or down one flight of stairs.

To the passenger in the dual elevator the cars are conventional in every way, and he is not conscious of the existence of the other car, except for occasional waits at starting, as the lower car cannot start until the upper car has gone a little way, and for occasional floor stops with no one getting on or off, in case the two cars get a little out of schedule and approach each other too closely. It is obvious that to minimize these waits the two cars must be very carefully scheduled and the load must be divided between them, so that the round-trip time of the upper car will be just a little longer than that of the lower car, but not enough to keep the lower car waiting at the bottom terminal. This suggests that the highest floor for the lower car and the lowest floor for the upper car be changed from time to time if the traffic demands require it, to adjust the relative round-trip times of the two cars to the proper values with respect to each other. By this means some confusion due to the change of directional signs for the two loading levels can be avoided.

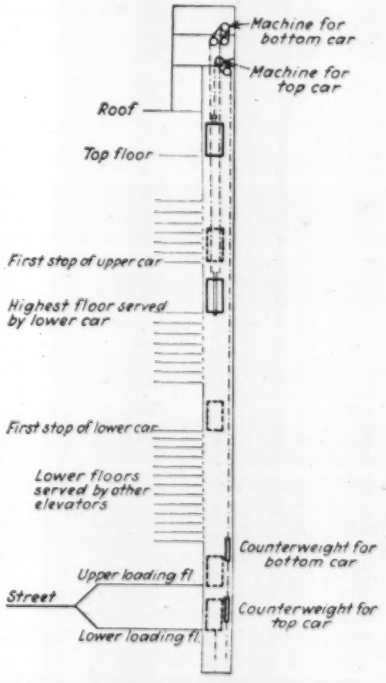


Fig. 2—The dual elevator with two cars in one shaft. (Westinghouse Electric & Manufacturing Co.)

The elevator shafts in One Wall Street, the Irving Trust Co. building, were laid out so that, if future traffic should demand, dual elevators could be installed in the high-rise shafts. These elevators were installed by the Otis company, which is also prepared to put in the dual type, just as the Westinghouse company is prepared to install the double-deck type.

Comparison of dual with double-deck

Comparing double-deck and dual elevators, the chief points are:

(*a*) The probable number of stops per trip, or per unit number of passengers carried, is generally conceded to be less with the dual elevator. That is, either of the two separate cars that run in the common shaft may be expected to make the same number of stops in relation to floors served if operated in the conventional way in a separate shaft, while the double-deck elevator will make somewhat more stops because some of the stops will be only for one compartment or the other and not for both at the same time. Therefore the traffic-handling capacity per shaft may be expected to be greater for the dual elevator under certain conditions.

Just what this efficiency ratio is and just how either compares with separate cars remains for experience to demonstrate. If the traffic-handling capacity of *two* separate elevators serving a given number of floors is put at 100 per cent, the capacity of a dual elevator of the same platform area and same number of floors might be between 90 and 95. The capacity of the double-deck elevator may be between 75 and 90. These figures would apply where there is a considerable number of stops to be made and where the single-deck separate elevators with which the comparison is made are efficiently operated in local and express banks.

Where the traffic is very dense and the rise and possible number of stops are small, the efficiency of the dual or double-deck elevator should approach unity as compared to two separate elevators, and in certain cases should exceed it.

Take, for example, the case of a building of moderate height covering a great area and having a very large population per floor, as a public building twelve stories high that would require twelve elevators serving all floors to handle the traffic. In such a case six double-deck elevators would give actually better service than twelve single elevators. The double-deck cars would take less time per round trip because of the fewer stops, and at the same time would carry twice as many passengers. The dual elevator would make a similar showing.

(*b*) The double-deck elevator costs less per shaft. If the cost of the two separate elevators were 100 per cent, the cost of the dual elevator may be expected to be at least 100, and of the double-deck between 65 and 75. There can be no general rule, as every job is different.

(*c*) The double-deck elevator is simpler and follows conventional practice more closely.

(*d*) The double-deck elevator re-

quires that the spacing of the floors be uniform. To offset this limitation, the Westinghouse engineers suggest an adjustable compartment that can be raised or lowered automatically with relation to the other to accommodate unequal story heights.

(*e*) The dual elevator requires a relatively larger shaft to get the necessary clearances for the extra hoist, compensating and traveling (electric) cables.

(*f*) The dual elevator should be somewhat more economical to operate during off-peak traffic when one car is shut down and the other makes all stops. On the other hand the double-deck elevator should be more economical at full load.

The most favorable case for the dual elevator is the small tower building of very limited area where the number of shafts is limited by space considerations regardless of the service and where it is therefore necessary to get the very highest traffic-handling capacity regardless of cost. Put in another way, if a fair number of elevators can be installed, as in Sixty Wall Tower, where eight can be accommodated easily, the double-deck elevator gives adequate service at a good deal lower cost. But if the section were so small that only four cars could be installed, the service (as measured by length of interval) is going to be bad anyway, and the dual elevator should make it a little better than the double-deck elevator.

The plaza floor

A third method of saving space is the use of the plaza floor. This means that the building is designed as though it were two or more separate buildings, one on top of the other. The lower section is served by conventional elevators in the conventional way. At the top of the lower building is the plaza floor for the building above. From this floor up the building is also served by conventional elevators, but these do not run below the plaza floor. Passengers for the upper building are conveyed to the plaza floor by express elevators that run non-stop between the ground floor and the plaza floor. As the number of these non-stop elevators is much less than the number of shafts required for the upper building, which in conventional practice would have to be carried down through the lower building, there is a very considerable saving in space.

There is also a saving of floor space in the upper part, because the elevators there, having a shorter travel, take less time per round trip, so that fewer cars are needed. This gain in space is made at the expense of inconvenience to the passengers who have to change cars at the plaza floor. How much this inconvenience would hamper the profitable renting of the upper floors remains to be seen. The actual time in getting to and from one's office would probably not be lengthened; it is only the psychological effect on the tenant who can go to some other building and ride up without change. One incidental advantage of the system is the fact that the change at the plaza floor gives the descending passenger time to readjust his organs to the change in air pressure. But in addition the system is simpler and probably cheaper than the dual or double-deck system in many instances and requires no departures from standard practice so far as the machinery is concerned. The success of the plaza floor would seem to be largely a matter of adjustment of passenger habits.

The offset elevator

To avoid the necessity of changing cars at the plaza floor, it has been proposed that passengers be transferred mechanically by having a detachable cab in the car frame that could be translated sidewise from the non-stop express car to the local car at the plaza floor, and so carried to the upper floors. This is the so-called offset elevator.

On paper the proposal looks fairly simple, but the practical problems are large. Horizontal transfer of a car with a number of standing passengers must be done very slowly, otherwise they will be jostled together and inconvenienced more than if they got out and walked across the hall. The mechanical transfer also would take more time than natural transfer.

The five-deck elevator

The principle of the double-deck elevator can be carried beyond two compartments. Three or even five decks in one frame can be used. In such installations three or five loading levels must be used, which means a rather complete change from the conventional entrance and lobby arrangements and the use of escalators to facilitate rapid movement to the proper levels. The cars, making but few stops in a round trip and handling a large number of passengers at one lift, could show a very rapid movement with dense traffic once the public became accustomed to multiple-level loading. A five-deck car could make all stops regardless of signals and thus could simplify the control system.

True express elevators

The plaza floor idea can be carried further by having full-rise high-speed elevators running to the top of the building with only three or four tops en route, always at certain floors, where passengers for floors between the express stops get out and change to local cars, as many people do now in the subway.

Three elevators in one shaft

A further development of the plaza floor idea, particularly applicable to very tall buildings, is that of three or more elevators in one hoistway, each confined to a fixed part of the height, the upper cars descending only so far as would leave sufficient clearance above that below to accommodate the hoisting machinery for the lower and the pit for the upper. Each car is a local for its own zone and is reached with one change by an express car to its lower terminal. The express cars make only the stops necessary to serve the lower terminal of the locals, and the intermediate floors.

It is obvious that combinations of the dual or double-deck elevators with a plaza floor system are entirely practicable.

The continuous conveyor

The loop circuit has intrigued the minds of elevator engineers for a long time. Cars would run up one hoistway independent of each other, one after the other, and would descend in the adjacent hoistway. The practical difficulties are obviously enormous. Separate hoists seem out of the question for such a scheme, while the continuous chain or cable has its own difficulties. A detachable grip, like the old cable railway, presents the problem of mechanically retarding, holding and accelerating the detached car at each stop, and doing it safely and comfortably. The continuous-chain conveyor, on the principle so long in use industrially, would have to be operated at very low speed. This has been done abroad, where the lifts move slowly enough for passengers to get on and off.

From the point of view of the present problem, however, the very object sought—gain in speed—would be defeated by the loop circuit. This is because the time of travel between stops is less than the time for the stops, and every car stopping would inevitably stop those behind, whether attached to the same chain or independent. The only way to operate would be either to operate on a skip-stop system, introducing an added group of local elevators, or to make the whole run at slow speed as a sort of glorified escalator. The escalator is indeed capable of further development for handling large populations in the lower floors of large office buildings.

Tower limitations

It has been apparent in the discussion that a vital factor in the elevator problem is the restricted area of the tower portion of buildings erected on small plots. These restrictions may be looked on to some extent as artificial. The New York zoning law is not the law for other sections of the country. Yet it is likely that any other community that has not done so will adopt similar measures once the city blocks tend to be so closely built on narrow streets as to obstruct the light unduly. Even if some plan were adopted, as has been proposed, to build detached towers without setbacks but with plenty of space between buildings, the same elevator problem will appear.

The Equitable Building, at 120 Broad-

way, New York, was built before the day of the zoning-law type of setback building with 25 per cent tower area. It rises 39 stories all round (40, including the roof, which is used commercially), on a plot area of 50,000 sq.ft. The net rental area is 1,230,000 sq.ft., a ratio of rental area to plot area of 24.6 to 1. A similar ratio has been achieved in a number of later buildings, which are carried higher but with the area restricted in the upper floors to comply with the newer laws. Space in the upper floors not being at such a premium, it was easy in this building to provide enough elevators for all floors. There are 62 elevators, of which 40 are passenger elevators in five banks of eight each. The average interval of departure from the ground floor is 21 sec. for the high-rise bank and 13 for the low-rise bank, so that the elevator service in this building, built seventeen years ago, is as good as in any building in New York today. The cars are old-fashioned, according to present-day standards, but the operating and upkeep costs are still very low per unit.

From this building it might seem that the elevator problem is simplified, if not almost solved, if a large enough area and an unrestricted height for the outside walls is granted. This might be true if consideration of economy did not vitally influence the construction of the building. And of course the two premises are not to be assumed at all in most cases.

A lot of the rental area of the Equitable is unproductive because it is too far from the outside light. There is no real gain in carrying the plot area too high, even if it were unrestricted. When Empire State was built, it was decided to make it practically all tower. The street fronts were not carried as high as the law would have permitted; the gloomy interior could not have been rented. The street walls run up only six stories.

When Rockefeller Center was designed, the 69-story building was in effect laid out in this fashion: The general proportions, height and number of elevators having been determined (and these last were set at eight to a bank with only about fourteen floors served per bank, to insure a first-class interval), the elevator shafts and other services were blocked in, and a line was drawn about 27 ft. out from these all around. This was the outside of the building, and a setback occurs at each level where a bank of elevators stops. An office depth of 27 ft. was considered the optimum for attracting tenants, and any greater depth was considered waste.

Thus it will be seen that from whatever angle the problem is approached, it gets back to the problem, in the higher buildings, of getting the greatest output in vertical transportation per square foot of space taken and per dollar of expenditure.

In the present article and the earlier one we have shown how the problem of installing enough elevators to give good service limits the economic height of a building. It is the elevator problem rather than the problems of the structure that limited our tallest building to 80 rental stories and the average of the next ten buildings to less than 60. We have shown that there are ways of pushing this economic limit upward, so far as the technical problems of elevator installation are concerned; the principal change needed will be in passenger habits, and this change will be small, in fact no greater than changes in elevator habits to which passengers have already accommodated themselves in the recent past.

If there is a need for it, a super-skyscraper 150 stories high is practicable from an engineering standpoint and can be adequately and economically elevatored. It may be some time before this is done, however, because of other factors, such as lack of demand due to present excess of supply of space, and the vital question of traffic congestion, which a large concentration of population in such a high building would entail. Empire State can house 19,000 people; but can the streets and transportation systems take care of Empire State comfortably when it is full? Moreover, changes in land values enter as a potential factor, for there is the definite possibility of a decrease in the desire to be as high up as possible. Any such change would render the tower floors in less demand and would fix the point of diminishing returns lower down.

In the meantime, with the return of activity in the construction industry, the new elevator systems offer for buildings of moderate height an opportunity for genuine economy and a better chance to survive in the new competition.

Understressing and Notch Sensitiveness in Fatigue

The "coaxing" effect of repeated understressing is found greatest when the initial stressing is close to the endurance limit and may be increased by progressive raising of the stress—Notches weaken cast iron less than steel

By Prof. J. B. Kommers
Professor of Mechanics, University of Wisconsin, Madison, Wis.

WITH THE growing conviction that, since purely quiet loading is only an ideal, a potential "fatigue" action is present in structures as well as in machines, the mysterious phenomena of fatigue failure have acquired practical importance for civil engineering work. Two peculiarities of fatigue are especially significant with respect to structures: the effect of stress repetitions below the critical fatigue stress or endurance limit, and the effect of sharp corners or notches. It was observed some years ago and later confirmed by ample evidence that, curiously enough, understressing does not weaken the material but on the contrary strengthens it, possibly by opening up and rendering harmless the minute flaws from which fatigue failure is supposed to start; this is the well-known "coaxing" effect. It was also found that sharp corners or notches lower the endurance of materials. Both effects bear on the structural engineer's demands and working stresses. Prof. J. B. Kommers, an experienced student of fatigue, has now found in new investigations here reported that understressing is much more important than previously believed, and that it may strengthen material one-third or even more when its most favorable conditions have been found. He has also discovered that, contrary to common belief, notches are more harmful in ductile steel than in brittle cast iron, so far as fatigue failure is concerned. Both discoveries render engineering command of fatigue phenomena more definite.—EDITOR.

❖ ❖ ❖

THE PHENOMENON known as understressing in fatigue may be explained by the S-N diagram, shown below, in which the unit stress is plotted as the ordinate, and the number of cycles for rupture is plotted as the abscissa. The S-N curve approaches a horizontal asymptote the "endurance limit," at large numbers of cycles by a more or less abrupt knee in the curve. If the applied unit stress is below the endurance limit in a normal specimen, failure will not occur, but when a material is subjected to repeated stresses below the endurance limit it acquires a higher endurance limit. This strengthening effect of understressing has been observed with steels, cast irons, non-ferrous metals and even with concrete. There seems, however, to be a great variation with different materials in the percentage of strengthening that can be obtained by this repeated stressing below the endurance limit.

In a paper before the American Society for Testing Materials in 1930, the writer discussed the percentage of strengthening as affected by the number of cycles of understressing applied and by the stress used. The preliminary experiments were carried out by means of rotating-beam tests on a low-strength

cast iron with a tensile strength of 20,000 lb. per sq.in. and a normal endurance limit of 9,300 lb. per sq.in.

TABLE I — EFFECT OF NUMBER OF CYCLES USED IN UNDERSTRESSING CAST IRON

Original endurance limit: 9,300 lb. per sq.in.
Stress used in understressing: 9,000 lb. per sq.in.

Cycles of Applied Understress	New Endurance Limit, Lb. per Sq.In.	Increase Over Original Endurance Limit, Per Cent
2,500,000	10,500	12.9
5,000,000	11,000	18.3
10,000,000	11,200	20.4
15,000,000	11,600	24.7
20,000,000	11,600	24.7
30,000,000	11,600	24.7
40,000,000	11,600	24.7

In obtaining the results shown in Table I a unit stress of 9,000 lb. per sq.in. (slightly below the endurance limit) was applied for a given number of cycles, as shown in the table. After this preliminary run on ten or fifteen specimens at the given numbr of cycles the ordinary fatigue test was made in each case to determine the newly acquired endurance limit. The results in Table I show that the maximum percentage of strengthening was obtained after 15,000,000 cycles of understressing. Similarly the results given in Table II show that the most effective stress to use for understressing is one that is as close as possible to the endurance limit. This produced a strengthening against subsequent fatigue of 31 per cent.

TABLE II — EFFECT OF UNIT STRESS USED IN UNDERSTRESSING CAST IRON

Original endurance limit: 9,300 lb. per sq.in.
Number of cycles of understress applied: 20,000,000

Unit Stress Used in Understressing, Lb. Per Sq.In.	New Endurance Limit, Lb. Per Sq.In.	Increase Over Original Endurance Limit, Per Cent
9,300	12,200	31.2
9,000	11,600	24.7
8,500	11,400	22.6
8,000	10,800	16.1
7,500	10,800	16.1
7,000	10,800	16.1
6,500	10,800	16.1

In all the above experiments the stress used in understressing remained constant. The question then arose as to whether the amount of strengthening could be increased further if the unit stress used in understressing were gradually increased, using a run of five, ten or more million cycles for each increment of stress.

The theory upon which these new experiments were based was as follows: Tests on hot-rolled iron have shown an endurance limit above the yield point; stressing at the endurance limit therefore must involve plastic action, but as failure does not occur the metal evidently readjusts itself to elastic action under this stress. Tests on concrete have shown that for a stress somewhat below the endurance limit the first 200 to 400 thousand cycles produce plastic action or permanent deformation while thereafter the material adjusts itself to the stress imposed and the material seems to be perfectly elastic. These facts would indicate that in an ordinary fatigue test there is probably a strengthening and a destructive action proceeding simultaneously. It would seem possible to strengthen the material more by progressive understressing with small increments of added stress than by a constant stress at or just below the virgin endurance limit. If so, two factors must be discovered: The most favorable increment of stress to apply after the first understressing and the number of cycles of stress that will be sufficient to produce the strengthening effect. The experiments on cast iron, for instance, showed that the maximum strengthening was obtained at about 15,000,000 cycles. A number of cycles less than this would not produce the maximum strengthening possible, and a number greater than this produced no further increase in strengthening. It is obvious, of course, that experiments of this nature will require very long runs, as the technique to be used is one that is not intended to cause failure.

Progressive understressing

In preliminary experiments made while the author was trying to determine the amount of strengthening against a *single* large increment of stress, the material used was cast iron (original endurance limit, 9,300 lb. per sq.in.), and the unit stress used in understressing varied from 6,500 to 9,300 lb. per sq.in. A specimen might be understressed at 9,000 lb. per sq.in. for 20,000,000 cycles, and then the increment of added stress would bring the unit stress to, say, 11,000 or 11,500 lb. per sq.in. If failure did not occur after five or ten million cycles, the test was continued by applying successive increments of 300 lb. per sq.in. for about 5,000,000 cycles each. The first large increment was probably too large to keep the strengthening effect in advance of the destructive effect. At least under these conditions the increase of endurance limit never exceeded the 31 per cent maximum shown in Table II.

Some of the experiments on hot-rolled iron, however, indicated that there may be a certain optimum increment of unit stress and number of cycles. After understressing at or just below the endurance limit at a constant unit stress, hot-rolled iron could be strengthened about 10 per cent. But progressive understressing gave a much larger strengthening, thus: The endurance limit of the virgin material being 26,200 lb. per sq.in., a specimen was tested as follows:

Unit Stress, Lb. Per Sq.In.	Increase Above Virgin Endurance Limit, Per Cent	Number of Cycles
26,000	0	20,338,300*
28,700	9.6	10,149,600*

*Tests in which failure did not occur.

Thereafter the increment of unit stress was made 500 lb. per sq.in., applied in each case for 5,000,000 cycles. The specimen failed at 32,600 lb. per sq.in. after 2,800,500 cycles, which was 24.4 per cent above the original endurance limit.

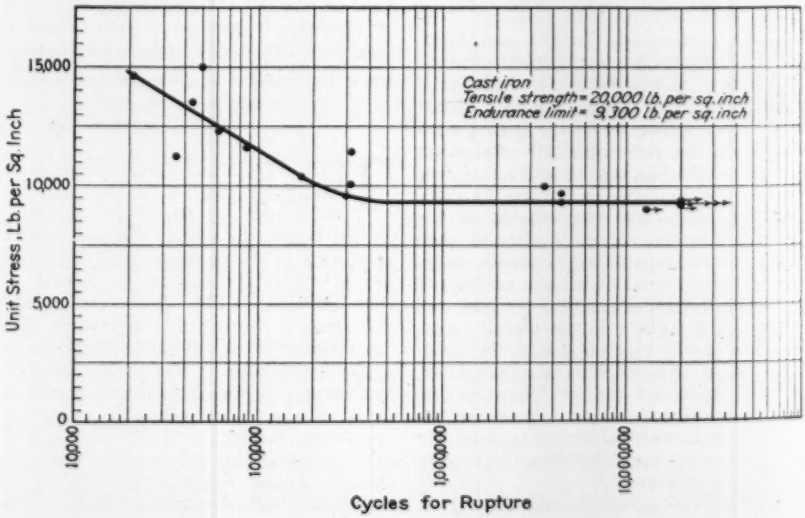
Another specimen was tested as follows:

Unit Stress, Lb. Per Sq.In.	Increase Above Virgin Endurance Limit, Per Cent	Number of Cycles
25,800	0	2,348,600*
26,400	0.8	2,681,200*
27,000	3.1	2,474,400*
27,500	5.0	2,564,700*
28,100	7.3	2,783,800*
28,600	9.2	2,359,600*
29,200	11.5	10,457,000*
29,600	13.0	6,943,900*
30,200	15.3	2,629,000*
30,800	17.6	5,105,100*
31,300	19.5	5,329,000*
33,000	26.0	1,508,000

*Tests in which failure did not occur.

The tests on these two specimens show that by using small increments of stress the amount of strengthening obtained

Typical endurance-test curve, with stress plotted against number of cycles to failure, from a set of rotating-beam tests on cast iron. Arrows denote tests in which failure did not occur.



was about 2½ times as much as when the understressing was carried out at a constant unit stress. The writer is at present carrying out experiments on both cast irons and steels to determine the precise increment of unit stress and the corresponding number of cycles to obtain the maximum amount of strengthening.

Effect of homogeneity

The tests on hot-rolled iron indicated that this homogeneous material could be strengthened only about 10 per cent, using a constant stress in understressing. Under similar conditions a cast iron with an ultimate tensile strength of 20,000 lb. per sq.in. could be strengthened about 31 per cent. This indicated that in the ordinary fatigue tests the homogeneous material develops a much greater proportion of the maximum possible endurance limit than does the non-homogeneous cast iron. The writer is at present experimenting on 0.30, 0.60 and 0.90 per cent carbon steels and on malleable cast iron, to determine whether these materials will be strengthened a small or a large amount according as they are more or less homogeneous.

Increase of cycle resistance

Many of the results obtained on cast iron show evidence that understressing has strengthened the material so that even at a failure stress it can withstand a greater number of cycles than would have been possible in the virgin condition. In the following case the numbers of cycles for failure was increased by 150 per cent:

Unit Stress, Lb. Per Sq.In.	Increase Above Virgin Endurance Limit, Per Cent	Number of Cycles
9,030	0	30,204,600*
11,500	23.6	9,932,400*
11,800	26.8	4,910,700*
12,100	30.1	1,000,800
9,050	0	20,071,100*
11,500	23.6	10,268,000*
11 800	26.8	5,005,800*
12 100	30.1	1,261,900

At a unit stress of 12,000 lb. per sq.in. a virgin specimen would have failed at about 75,000 cycles. In three other cases increases up to 4,500 per cent were realized:

Unit Stress, Lb. Per Sq.In.	Increase Above Virgin Endurance Limit, Per Cent	Number of Cycles
8,980	0	42,050,900*
13,300	43.0	85,900
8,970	0	40,046,400*
12,400	33.3	906,900
9,200	0	20,396,300*
12,400	33.3	2,726,900

At a unit stress of 13,300 a virgin specimen would have failed at 40,000 cycles, and at 12,400 it would have failed at 60,000. On the basis of number of cycles the first case shows a strengthening of 214 per cent, the second of 1,500 per cent, and the third, which is for a smaller number of cycles of understressing, a strengthening of 4,500 per cent. Dozens of similar cases might be cited.

Some conclusions of immediate practical interest are:

1. Usually the endurance limit of virgin material should be determined by tests that apply a constant unit stress, as any understressing tends to strengthen the material.

2. Some aluminum alloys have a very flat S-N diagram and require hundreds of millions of cycles before the endurance limit can be determined definitely. In such cases there may be some merit in carrying out fatigue tests in which the applied stress is increased, for if the specimen does not fail after a considerable run at one stress, and is then run at the higher stress for a greater number of cycles than virgin material at the same stress, the first stress probably was below the endurance limit, because the material has evidently been strengthened. On the other hand, if at the increased stress the specimen fails after fewer cycles than virgin material, the first stress probably was above the endurance limit, because the material has been weakened. Thus the endurance limit can be determined indirectly by virtue of this knowledge.

3. Subjecting a machine to preliminary runs at less than its rated capacity will very likely strengthen those parts that are being subjected to fatigue action. Stated in another way: A machine that has run satisfactorily for years without fatigue failures, if properly designed and not at times overstressed, is probably stronger in those parts subjected to fatigue than it was originally.

Experiments on notch effect

The previously mentioned paper pointed out that when cast iron was prepared so that the specimen had an imposed notch with square shoulders the endurance limit was not reduced, although such a notch in steel would reduce the endurance limit about 50 per cent. The explanation is that the flakes of graphite in cast iron are themselves discontinuities in the metal, comparable to notches, so that the square notch is no more serious in reducing the endurance limit than the graphite flake notches already present in the metal. This explanation is supported by the observation that in many cases the final failure of the notched specimens did not occur at the corner of the notch, but away from the corner, while notched specimens of steel and hot-rolled iron always failed at the corner of the notch.

There were not enough notched specimens of this cast iron available to study the effect of understressing thoroughly, but enough results were obtained to show that these specimens also could have their endurance limits increased by understressing. Understressed at or just below the endurance limit, these specimens were strengthened between 25 and 30 per cent.

The notched specimens were also greatly strengthened in their cycle resistance against stresses that would cause failure, thus:

Unit Stress, Lb. Per Sq.In.	Increase Above Virgin Endurance Limit, Per Cent	Number of Cycles
9,520	2.4	20,422,300*
12,600	35.5	1,457,100
9,450	1.6	20,426,800*
12,300	32.3	4,797,100

At a unit stress of 12,600 a virgin notched specimen would fail at about 30,000 cycles, and at a unit stress of 12,300 it would fail at 35,000 cycles. On the basis of the number of cycles, therefore, the first specimen was strengthened 4,800 per cent, and the second 13,700 per cent. Many similar results were obtained.

Brittle materials, such as cast iron, are usually looked upon as being particularly sensitive to abrupt changes of cross-section due to a notch or a fillet. Fatigue tests on cast iron prove that this is not necessarily true.

TABLE III — EFFECT OF SQUARE NOTCHES ON ENDURANCE LIMIT

	1 Ultimate Tensile Strength, Lb. Per Sq.In.	2 Standard Specimen Endurance Limit, Lb. Per Sq.In.	3 Notched Specimen Endurance Limit, Lb. Per Sq.In.	4 Decrease of Column 3 Compared With Column 2, Per Cent
1	20,000	9,300	9,300	0
2	23,200	11,800	11,200	5.1
3	30,300	15,000	13,700	8.6
4	37,100	19,500	16,300	16.4
5	42,500	24,100	19,100	20.7

It will be noted that as the strength of the iron increases the material becomes more sensitive to the notches, with the result that the endurance limit is reduced by a greater percentage.

Moore and Kommers showed (in Bulletin No. 124, University of Illinois, 1921) that a 0.49 per cent carbon steel in the sorbitic condition and also annealed hot-rolled iron had their endurance limits reduced about 50 per cent by an imposed square notch. These ductile metals, therefore, were more sensitive to notches than the cast iron.

Another observation that should be made in this connection is that the endurance ratio (ratio of endurance limit to ultimate tensile strength) is as high for cast iron as it is for the steels. The writer has determined the endurance limits of about 35 different cast irons and finds that the average value of endurance ratio is 0.50. The average endurance ratio of steels is also usually given as about 0.50.

Refuse Dumps as Sewage Filters

Dumps of domestic refuse are used as sewage filters at Chester, England, according to an article by Charles Greenwood, in the *Surveyor*, London, June 10, 1932, p. 576. Experience indicates that the beds will yield about 200,000 gal. per acre daily. After they have been in use for about a month they are closed down, left to dry, and the surface is cleared of weeds and harrowed. The beds are then rested for a week before being put into use again.

Engineering News-Record

EDITOR—F. E. Schmitt. EDITORIAL STAFF—V. T. Boughton, W. G. Bowman, F. W. Herring, C. S. Hill, H. W. Richardson, W. W. De Berard, N. A. Bowers, J. I. Ballard.

Editorial and Publishing Offices at 330 West 42d St., New York; 520 North Michigan Ave., Chicago; 883 Mission St., San Francisco; Aldwych House, London, England.

Subscription price $5 per year in the United States; foreign rates on application.

Copyright 1932 by McGraw-Hill Publishing Co., Inc.

SEPTEMBER 22, 1932 Volume 109 Number 12

Not Only Waterworks Men

FOR reasons outlined on the opening page, most of this issue is devoted to a series of articles discussing the new aspect of water-supply planning and management that results from the self-liquidating requirements of the Relief Act. In a broad sense, however, this is not a waterworks issue. Water service is a primary field for R. F. C. loans because it has always been self-supporting, but questions arise when the self-liquidating provisions are considered that are of broad implication. Closely parallel considerations arise in connection with other public services and improvements, and the group of articles should prove helpful to engineers in many fields, as well as to all public officials concerned with utilizing the Relief Act. Thorough understanding of how the act may influence their administrative methods is essential if they are to apply it most effectively to their requirements.

Better Bookkeeping

FAIRNESS to the taxpayer as well as good business principle argues for adhering to the practice of assessing adequate service charges for public services, wherever such charges are appropriate. This means not only compensatory rates and discontinuance of free service, but also strict accounting procedure to reveal true cost. No one factor has done so much to confuse the facts about government economy as incompleteness of cost figures in conventional municipal accounting. Construction-cost carrying charges, land interest and taxes are rarely included in the expense, while credits for free services are omitted from revenue. If the accounts are to be so kept as to cover all costs from revenue —as implied by the self-liquidating requirement of the Relief Act— these defects should disappear, and the particular service involved will be seen in its true financial light. This valuable result, however, ought to be retained after the Relief Act is a thing of the past. Truer and more informative city bookkeeping is sure to bring better city management, more citizen interest in its doings, and lower taxes.

A Bit of Sunshine

IN CONJUNCTION with the recent rise in engineering construction contracts, the report of increased industrial employment during August in that great manufacturing state, New York, is a welcome bit of sunshine. There is much more light on the road ahead than there was in the gloom of three months ago. In addition, two powerful forces are now in action to build up employment more rapidly—distribution of the huge construction fund established by the Relief Act, and systematic stimulation of industrial rehabilitation by the five working groups of the semi-official Banking and Industrial Committee. The R.F.C., though slow to get started on construction loans, is now striving energetically to sift and approve projects so as to convert its resources into employment. At the same time the industrial rehabilitation committees have organized and are at work, seeking to discover all proper opportunities for bringing plants up to best efficiency. In this process, also, manufacturer and banker are to be brought together, so that funds to carry out the modernizing may be made available as freely as possible. The two efforts promise an early reduction in unemployment. At the same time they give notice to industry that it may soon be called upon for prompt service in filling requirements of construction and of plant modernization, and that unless each plant is in efficient working shape it may not share in the new demand.

Relief Highway Funds

WIDE misunderstanding exists as to why the books of the R.F.C. show that only a small part of the $120,000,000 set aside for emergency highway construction has been taken up by the states. Many believe it to be a sign that nowhere near the full amount authorized will be used, that the states are not alive to their opportunity to get money for needed work. The opposite is actually the case. The states are alive to their opportunity. The misunderstanding is due to a lack of knowledge of the workings of federal aid to highways. The states cannot go to the federal treasury and draw the amount allotted to them. They must first decide on each highway job for which they will ask for funds, must prepare their plans and estimates and present them to the U. S. Bureau of Public Roads for approval. If approved, bids must be called and ultimately a contract let. *After* the contract has been let for each job the federal-aid money becomes available. There need be no cause for worry that the money will not be used; our state highway departments are well organized and ready and are pushing their plans through to the contract stage as quickly as possible. The chief cause for worry centers in the amount of work on self-liquidating projects that can be made available to relieve unemployment this winter. If plans for such projects were as well along as are the highway plans increased employment would spread more generally into the larger centers of population.

A Plan Takes Form

NOTABLE in several respects is the new inland freight terminal of the Port of New York Authority. Its outstanding feature is its potential capacity for eliminating many miles of truck and dray movement now required in delivering freight to the scattered receiving stations of the many railroads serving Manhattan Island. As a corollary there should be a lessening of street congestion. Eight railroads will use the terminal, each having platform space for the receipt of freight. A shipper with freight for several lines will bring it all to the union terminal for transfer to the trucks of the several railroads. Each railroad, in turn, will consolidate the shipments received and truck them direct to its own rail terminal—chiefly on the mainland in New Jersey—or to its car-float stations on the waterfront. The advantages of such an arrangement are obvious, but the obstacles in the way of its accomplishment were

formidable. The new terminal thus stands as concrete evidence of the Port Authority's ability to get eight railroads to agree to such an innovation. Further, the terminal is significant evidence that the plan of coordinating all the transportation agencies of the port—the plan for which the Port Authority was set up as the central agency of the two states and many municipalities —is beginning to take form. As it is working out, the port development plan bears little resemblance to the so-called "comprehensive plan" that was embodied in the acts establishing the Port Authority. But that plan was drafted nearly 15 years ago, and even then there was question as to some of its principal elements. Radical departures from it are, therefore, to be expected. They are indicative of the fact that the engineers of the Port Authority are not subordinating present needs to conditions and ideas of the past.

The R. F. C.'s Position

IN the light of the illuminating statement of the Reconstruction Finance Corporation's views and the problems confronting it, published on another page, it is clear that the directors of the Corporation are working with all energy to carry into effect the construction provisions of the Emergency Relief and Construction Act. This fact together with the recent grant of the first loan revives hope that funds will soon flow out in sufficient volume to increase employment materially. Industry waits as anxiously as the wage earner for Relief Act construction to open up, since industrial revival is dependent on the demand which comes from new purchasing power.

It is idle to ignore the fact that discouragement and even alarm have grown up in many quarters over the Corporation's slowness in handling construction loan applications. Many have come to believe that the Corporation is negative rather than positive in its attitude toward the Act, that it failed to appreciate the existence of an emergency and the seriousness of the responsibility placed upon it. Contributing to this belief was the absence of clear interpretation of the terms of the Act, the delay in issuing instructions to applicants, the elaborate requirements and inconclusive nature of *Circular 3*, the restrictive legal attitude on special assessments and other questions, and the unwillingness of the Corporation to declare itself as to rates of interest. Complaints about such matters are natural and inevitable, for the viewpoints of loan applicant and credit authority necessarily diverge. But back of all the criticism and complaint was the solid fact of the Corporation's slowness to act, and the rapid flight of the winter season when loans would be most effective in contributing to business recovery and in reducing the need for winter relief.

It is not too late to recover some of the lost time. But here let us remember that, whatever the Corporation may have contributed to the delay, the applicants themselves must shoulder much of the blame. A flood of incomplete applications, lacking the barest fundamentals of a statement adequate to justify a credit grant, could not but lead to loss of time. Speculative projects, some of them distinctly of wildcat character, were proposed for loans in some instances, although even superficial study of the Act would have shown that they could not meet its provisions.

Correspondingly, a large share of responsibility for bringing about quicker action on loans rests on the applicants and prospective applicants—the officials of local governments and of private companies seeking loans for works or improvements of public use. By determining whether their projects are meritorious in being self-supporting, by assembling proof of this fact and presenting the pertinent engineering data as to design and construction, and by giving all necessary information on legal authority and readiness of the work to proceed, they can so simplify the Corporation's work as to speed up the progress of applications decisively.

Over and above this, however, is the supreme responsibility of the Corporation's directors and agents. Theirs is the assigned task of carrying out the purposes of the Act. No doubt the difficulties of the preliminary stages of applying the Relief Act have been exceedingly great. Two months, however, are time enough for organizing and getting through the preliminaries. If rapid progress is not realized from now on the Relief Act will in large measure be a failure and the Corporation's directors will have made it so. Such an outcome, in the face of the utter emergency in which the country finds itself, to relieve which is the very motive and essence of the Act, would be nothing short of national calamity. It is inconceivable that this should be permitted to occur; the country's joint contribution toward relief of unemployment must not remain idle. Whatever difficulties have heretofore stood in the way can no longer justify failure to put the money to work.

Water Needs of Tomorrow

MORE so than for most public facilities, the assurance of adequate water service is a long-time task. Years before the need for system improvements becomes apparent to the consumer, the engineer responsible for the water service must have planned for and inaugurated the necessary work. Supply systems cannot be enlarged on short notice, nor can purification plants be produced and installed in answer to a consumer's complaint.

It is not only because the engineering and construction proper are large-scale tasks taking an appreciable time that this is so. System improvements of any magnitude involve financial operations that in turn must be preceded by steps that can be taken only by legislative bodies or by the electorate, both of which are characteristically slow to act. Land acquisition must be accomplished through condemnation procedure, a leisurely judicial activity. And all these preliminaries can be upset quickly by public apathy or hostility, so that adequate preparation involves also the building up of supporting public opinion. The sum of these elements of time is to be expressed in years, typically ten or more for large projects.

The lesson is that the current timidity regarding public expenditure can have grave consequences if the test of being "absolutely essential" is rigidly applied to waterworks activity. Improvements in quality in certain cases may not be indispensable at the immediate moment, but when they become so they will be unattainable unless the preliminary work is complete. Quantities may appear to be sufficient for today, but it is certain that some day they will become insufficient and remain so for a distressingly long time if the institution of remedial measures is delayed until the condition becomes apparent. No community can afford to discontinue its preparations for waterworks betterments because it believes that the improvements are not needed at the moment.

NEWS OF THE WEEK

Final Approval Given to Loan For Railroad Line in Colorado

A loan by the Reconstruction Finance Corp. of $3,850,000 to the Denver & Rio Grande Western Railroad for the construction of the Dotsero cutoff was approved by the directors of the Corporation on Sept. 17. Last week the Interstate Commerce Commission approved this loan, as noted in our news pages, thus making it possible for the Reconstruction Finance Corp. to make the money immediately available to the railroad company to start construction.

Tunnel Contract to Be the First on Los Angeles Aqueduct Work

Because the time required to construct the 13-mile San Jacinto tunnel, the longest of the 240-mile aqueduct of the Metropolitan Water District of Southern California, it is expected that the contract for that work will be the first let by the district as soon as funds are available. As announced last week, the Reconstruction Finance Corporation will bid on $40,000,000 of the district's 5 per cent bonds. Present expectation is that it will bid on $20,000,000 this year and $20,000,000 before the end of 1933. This will provide sufficient money to carry the project forward for two years by which time it is expected that the district will be able to dispose of its securities through normal channels.

The engineering forces of the district, under the direction of F. E. Weymouth, chief engineer, have detail specifications for the first work ready for calling for bids as soon as money is available.

Engineering Board to Study Work on Madden Dam

Appointment of Elwood Mead, Commissioner of Reclamation, to be chairman of a board of engineers to study developments at Madden Dam, was announced by the Department of the Interior on Sept. 15. Other members of the board are: S. O. Harper, assistant chief engineer; J. L. Savage, chief designing engineer; and L. N. McClellan, chief electrical engineer of the Bureau of Reclamation.

The board sailed from New York for Panama on Sept. 22.

A contract for the construction of the dam was let about a year ago. It is located on the Chagres River about 10 miles above the point where the river enters Gatun Lake. The main structure is to be a gravity-type concrete dam flanked by dams of earth and rock fill. Several smaller earth and rock fill dams are to be built to close off side valleys. Unusual foundation problems are involved due to the presence of large cavities in the underlying rock. Pressure grouting with clay is being used to close off these possible channels for water to escape from the reservoir formed by the dam.

Engineers to Act On Local Boards For R.F.C. Loans

SERVICES of leading engineers of the United States will be made available immediately to the Reconstruction Finance Corporation to assist in handling applications for loans for self-liquidating construction projects. The tender of the services of the engineers has been made to the corporation by W. S. Lee, president, and L. W. Wallace, executive secretary, of American Engineering Council, who had been invited by the corporation to advise how the work relating to self-liquidating projects might be expedited. The arrangement with the council has been made for the specific purpose of benefiting those desiring to apply for loans on small projects.

In making this announcement Sept. 20 on behalf of the Reconstruction Finance Corporation, Harvey Couch, one of the directors, pointed out that while the large projects upon which loans have been or are expected to be sought necessitate and justify a considerable outlay for employment of an engineering staff in preparing applications for loans, the smaller projects cannot stand the overhead expense thereby involved. Mr. Couch further called attention to the fact that the arrangement that has been made is for engineers to act in advisory capacities in putting applications for loans in shape for expeditious considerations by the R.F.C. and is not intended to supplant in any way the usual engineering service necessary in connection with the actual construction.

The plan is that there be appointed on each of the 32 regional advisory committees of the Reconstruction Finance Corporation an outstanding consulting engineer who is willing to give his time and talent as a member of the advisory committee for the purpose of facilitating the presentation of applications to the R.F.C. for self-liquidating project loans. These consulting engineers will receive no compensation for their services but will give their time and advice to the R.F.C. to enable applicants as well as the corporation to get into immediate action, particularly upon the many smaller construction projects which undoubtedly can be made eligible under the relief act if properly conceived and presented.

It is evident, according to Mr. Couch that many of the agencies interested in smaller construction projects will need to be assisted in preparing their applications if the R.F.C. is to act upon them promptly. The directors of the R.F.C. are hopeful that with the assistance of expert consulting engineers on local advisory committees this needed technical advice will be forthcoming immediately. The larger projects which the R.F.C. will consider, in the main, have had the benefit of expert engineering and technical preparation. The smaller projects are of quite as much importance and interest in the smaller communities as large ones in the larger cities, Mr. Couch emphasized.

Contractors Consider System of Certified Building Appraisers

Sponsoring a model uniform state law for the establishment of a system of certified building appraisers is to be considered by the governing board of the Associated General Contractors of America at its meeting in Washington, D. C., Oct. 10-11. The inadequacies of the present building appraisal system are believed by the association to be the basic cause of mortgage bond defaults totaling millions of dollars and resulting in loss of public confidence in construction securities.

A preliminary draft of the proposed model law has been prepared for consideration by the board at its October meeting and officials of the association believe that general adoption of a regulatory measure along its lines probably would be the most effective way of assuring reliable appraisals.

The drafted bill would set up a board of five members appointed by the governor of the state, whose duty would be to regulate the practice of building appraisal and to examine and register those qualified to practice as certified building appraisers. The bill provides for an examination of applicants in the subjects of building construction and engineering, theory of appraisal values, industrial economics, quantity surveying, cost accounting and pricing and such other subjects which in the judgment of the board should be included. Those qualifying would be officially authorized to style themselves certified building appraisers and to use the abbreviated title of C. B. A. after their names.

The bill would limit applicants to those who have attained the age of 35 years and who have had at least three years practical experience as a building appraiser. Any person representing himself to be a certified building appraiser without having secured a certificate would be deemed guilty of a misdemeanor and subject to penalty. The bill also provides a penalty for the willful falsification of any report or statement bearing on any examination or investigation made by a certified building appraiser.

In addition to the question of certified building appraisals, the governing board of the Associated General Contractors also will consider numerous other problems of the construction industry and will closely check on the progress being made on the national construction program to relieve unemployment.

Construction Section Program for Safety Congress Outlined

The Construction Section of the National Safety Council will hold meetings Oct. 4-6 during the Washington Congress of the Council. Secretary of Labor W. N. Doak will address the section on the subject education will do more than regulation to promote safety. Other subjects will be an illustrated talk on hazards of building construction, the safety work of the Navy on its construction operations and the use made of accident statistics by insurance companies.

Unusual Freight Terminal in New York Ready for Operation

The first union inland freight station to be built by the Port of New York Authority as part of its plan for the development of the port facilities of the New York metropolitan district was turned over to the eight railroads that will use the terminal on Sept. 16. The freight station itself will occupy the basement and practically the entire ground floor of a 15-story building, being built by the Port Authority on the entire block between 15th and 16th Sts., 8th and 9th Aves., in New York, an area approximately 200 ft. wide by 800 ft. long. The 8th Ave. frontage of this structure is being given over to offices and the remainder of the upper floors to light manufacturing, warehouses and other industrial operations.

No railroad tracks enter the building. It is essentially a transfer point for shipments, both carloads and less than carloads, between trucks of the railroad companies and trucks of shippers in New York City. Its principal purpose is the elimination of the great amount of trucking now necessary in the delivery and collection of freight at the scattered terminals of the railroad companies on Manhattan Island.

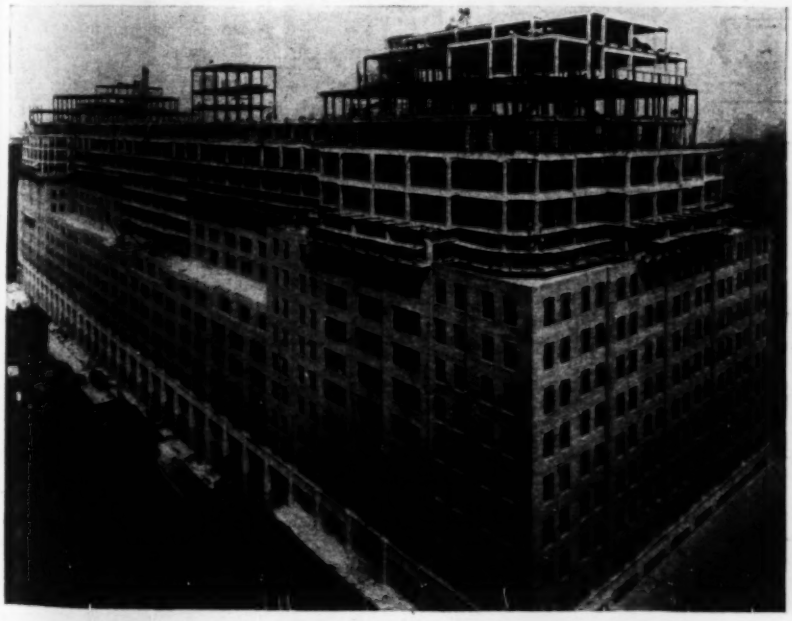
All outbound freight will be received at platforms along the 15th St. side of the building set back sufficiently from the building line to permit trucks to back in clear of street traffic. Inbound goods will be picked up at the 16th St. side of the same platform. Numerous large elevators connect the street level platform with platforms in the basemen where the freight will be consolidated for the several railroads and loaded by them into trucks for movement to their rail lines in New Jersey.

A notable feature of the building is the installation of truck elevators serving the upper floor so that goods moving in and out may be received and delivered to trucks on all the principal floor levels.

Construction of the union inland freight station was begun in April, 1931, and it is expected that the entire building will be completed in December of this year. The work was carried out under the direction of O. H. Ammann, chief engineer; J. C. Evans, terminal engineer, and M. B. Case, engineer of construction. The Goodwin Construction Co. had the general contract for the foundation work and the Turner Construction Co. for the superstructure.

In cubic content the building will be the largest in the city. Its contents will be 37,224,000 cu.ft. as compared with about 36,000,000 in the Empire State Building. The Merchandising Mart in Chicago has a cubical content of 53,000,000 cu.ft.

Eight railroads will use the lower floors of the union inland freight station now nearing completion in New York. The upper floors are to be leased by the Port Authority for commercial operations.



Wide Range Found in Bids on Sewer Job at Louisville

A difference of $413,000 between the high and low of fourteen bidders was disclosed on Sept. 15 when the Sewerage Commissioners of Louisville, Ky., opened bids on the second section of the Southwestern outfall sewer. The estimated cost of the sewer was about $1,000,000. The low bid, that of S. A. Healy of Davenport, Iowa, was $789,541 and the high bid of the Torson Construction Co. of Long Beach, Calif., was $1,202,608. The latter company has just completed the river section of the sewer, having taken over the contract from the bonding company following the failure of the original contractor to complete the work. The time estimated to complete the work ranged from 250 days to as high as 500 days.

Specifications call for the employment of Louisville labor except in the key positions and labor shifts of not more than 8 hours.

W. M. Caye is engineer for the commission. Because of the favorable character of the bids, it is believed that the commission may go ahead with other projects that are pending.

Arthur R. Hirst, Prominent Wisconsin Engineer, Dies

Arthur R. Hirst, for 17 years highway engineer of Wisconsin, died at Madison, Wis., on Sept. 17. Mr. Hirst had been ill for about four months. For many years Mr. Hirst has been active in matters relating to highway development both in his own state and throughout the entire country. He took a great interest in the American Association of State Highway Officials and served as its president in 1912.

Mr. Hirst was born in Elmont, N. Y., 52 years ago, and graduated in civil engineering from Maryland Agricultural College in 1902. His first work was with the highway division of the Maryland Geological Survey from 1903 to 1907, and in 1907 he went to the Illinois Highway Commission as assistant engineer. His stay in Illinois was brief, however, as he went to the Wisconsin Geological Survey in August of the same year to become highway engineer in charge of surveys, plants and construction of all road work of the Survey. In August, 1911, he was made acting state highway engineer and in September of the following year was made chief engineer of the Wisconsin Highway Commission with the title of state highway engineer.

In 1924 Mr. Hirst resigned his position as state highway engineer and ran for governor of the state but was not elected. Subsequently he was with the Vibrolithic Corp. and more recently has been in private practice as a consultant on highway work.

Many New Bridges Needed Ohio Survey Shows

Modernization of the highway bridges in Ohio by replacing those that are too light or too narrow for present traffic needs will require the replacement of 2,078 structures and will cost $20,000,000, according to a survey recently completed by J. R. Burkey, chief engineer of bridges in the state highway department. The state is responsible for the maintenance of 6,272 of the total of 6,847 bridges in the state system. Responsibility for the others is under municipal jurisdiction. A total of 813 bridges do not now come up to the legal load limit of 12 tons. All new structures being built by the highway department are designed for a load of 15 tons.

Very Low Streamflow Reported in Southeastern States

August streamflow in North Carolina is reported to be seriously low. A forecast bulletin on groundwater and streamflow conditions issued last week by Chas. E. Ray, Jr., chief engineer of the state department of conservation and development, states that the Tar River basin in August had a flow of 80 per cent less than normal, falling below the previous low record. The outlook here and in adjacent basins is for even lower flow, because of rainfall below normal and poorly distributed.

It is forecast that "rivers and larger creeks will shrink to unbelievably small flows, many smaller creeks will vanish, many springs will dry up, the water table will continue to fall and many wells will fail." Where there is likelihood of inadequate water supply, communities are urged to make contact with the state board of health.

Public-Works Loans Move Toward Action By R.F.C. Officials

SEVERAL of the public works projects for which loans from the Reconstruction Finance Corporation have been considered, in accordance with Title II of the Relief Act, have been advanced in stage toward definite action. In addition, reports have come to the attention of *Engineering News-Record* regarding other projects not heretofore mentioned.

The application of the Sanitary District of Chicago for a loan so that it might continue work on the Calumet, West Side and North Side sewage disposal projects and interceptors, reported in these columns last week as having been approved by the board of trustees of the district, was formally filed with the R.F.C. on Sept. 16. The attorney for the district, William Rothmann, has stated that the application requests the R.F.C. to buy $36,450,000 of bonds of the district out of the $43,000,000 worth recently issued. The Sanitary District has outstanding obligations of $90,000,000, he stated, and it has prepared specifications in readiness for advertising for construction work on which there will be expenditures of $2,500,000 in wages, if the loan is granted. Much more work is in prospect. The estimated entire cost of the sewage-plant project is $269,000,000, of which $107,000,000 already has been expended.

A delegation from California appeared before the Corporation on behalf of the loan application for the construction of the $75,000,000 bridge across San Francisco Bay from San Francisco to Oakland, filed several weeks ago. The matter was presented by Charles H. Purcell, chief engineer, C. E. Andrew, C. C. Carlton, attorney for the Department of Public Welfare, and Ralph Modjeski, of New York, consulting engineer for the project.

An application was formerly filed for a loan to build two bridges at Buffalo to connect Grand Island with Niagara Falls and Buffalo, to cost about $7,000,000, reported in these columns on Aug. 11. A delegation representing the Niagara Frontier Bridge Commission appeared before the corporation on behalf of the loan application on Sept. 13. They stated that the construction of the two bridges would provide work for 4,500 men. In addition to the bridge construction the state of New York is planning to spend $2,000,000 on state parks, one at each end of Grand Island.

Seattle loan rejected

Formal notice has been given by the R.F.C. that it will not consider the application for a $7,500,000 loan to the Seattle City Light Commission until all outstanding obligations on the Diablo plant are taken care of. The letter from the corporation says in part:

"The emergency relief and construction act of 1932 has as one of its principal purposes the creation of employment and for this reason loans for refunding or refinancing of obligations already outstanding are not held to be within the provisions of the act.

"The same question arises in connection with the borrowing of funds for the payment of the street railway substations in Seattle as per contract with the Puget Sound Power & Light Co.

"Therefore, it is the opinion of the corporation that that part of the loan applied for which is to be used for the purpose of liquidating outstanding construction warrants issued for the payment of material already used cannot be properly undertaken by this body.

"Until the corporation can be assured that other claims against the proposed bond issue have been disposed of, it does not appear possible for the application to be considered."

Members of the city council and Mayor Dore immediately took under consideration plans for submission to the voters of a $1,800,000 general bond issue to furnish funds for a loan to the City Light Commission for the purpose of paying off the Diablo indebtedness.

Small projects invited

On Sept. 19 Harvey Couch, a director of the R.F.C., made the following statement:

"The Reconstruction Finance Corporation desires to correct a false impression which seems to exist in the minds of some people to the effect that the corporation is not interested in making small loans for self-liquidating projects.

"It is the policy of the corporation to look favorably upon all applications regardless of the amount involved, if the projects meet the requirements of the act as to eligibility, self-liquidating character, soundness and sufficiency of security, and will create employment."

On behalf of the corporation, Mr. Couch suggested that applicants who are not able immediately to furnish all the information required should forward their applications with such information as is available and undertake to furnish the additional data in due course. By the filing of all available information concerning a contemplated project, at least preliminary examination and tentative action may be taken, according to Mr. Couch.

A resolution passed by the city council of Manchester, N. H., approves the construction of a water reservoir to cost $350,000 and its financing through the R.F.C.

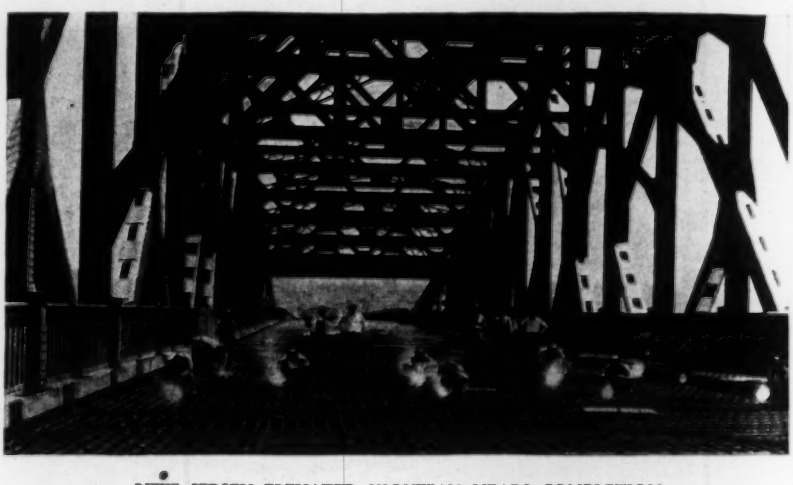
The city council of Owingsville, Ky., has decided to apply to the R.F.C. for additional funds to be used with a bond issue of $13,500 voted last fall for use in constructing a water plant.

Hoover Dam Notes

A pile trestle for dumping has been started below the intake portals at the Hoover Dam. A temporary diversion dam is to be built for the exacavation of the cofferdam foundations and a semi-circular cofferdam to extend half way across the river also has been started below the pile trestle so as to permit trenching and the driving of sheet piling. Stripping on the Nevada side above the upper cofferdam has been started and is being carried on above the valve house and the adit portals on each side of the canyon.

* * *

With the fall of the Colorado River to 10,500 sec.-ft. on Sept. 10, the normal operation of the Boulder City filtration plant again was possible, relieving the water shortage that had prevailed since the flood clogged the plant with silt.



NEW JERSEY ELEVATED HIGHWAY NEARS COMPLETION

With the construction of the concrete deck underway, the three-mile long viaduct being built by the New Jersey state highway department between Jersey City and the outskirts of Newark on the Holland tunnel approach highway is nearing completion. The steel work of the two high-level cantilever bridges over the Passaic and Hackensack Rivers has been completed for some time and erection of the 300-ft. span deck trusses, comprising the remainder of the structure, was finished in May. The above view shows welders at work on the bar truss deck reinforcing of one of the high-level bridges. The reinforcing which is received on the job in pre-fabricated mats is welded to the beams and stringers, and all intersections of the trusses with transverse bridging rods are also welded. There is a total of 925,000 sq.ft. of fabricated mat in the deck of the viaduct which is 50 ft. wide between curbs. According to the J. K. Welding Co., Inc., of New York, the welding contractor, the work is being done with 18 gasoline-driven 400-amp. machines and shielded-arc welding rods, 30,000 lb. of the latter being required for the job. The crew consists of a welding operator for each machine, and an engineer and one helper for each 3 machines. Progress so far has averaged 1,200 sq.ft. of mat per day per man. Fredburn Construction Co. has the contract for the concrete bridge deck and Taylor-Fichter Steel Construction Co. the contract for placing the reinforcing steel. For the New Jersey Highway Department, the work is under the supervision of H. W. Hudson and S. Johannesson.

Philadelphia Bridge Bond Bid Rejected As Inadequate

A conditional bid for the purchase of $32,000,000 of bonds of the Delaware River Joint Commission was unanimously rejected by the Commission on Sept. 16. The purpose of the bond issue was to repay to the states of Pennsylvania and New Jersey and to the city of Philadelphia the money put up by them for the construction of the Philadelphia-Camden bridge.

A banking group headed by the National City Co. of New York, the Chase Harris Forbes Corp., and the Chemical National Bank and Trust Co., proposed immediate purchase of $15,000,000 of bridge bonds bearing a 5 per cent interest coupon at 97, also a 90-day option on the remaining $17,000,000 of bonds. The offer was conditioned on postponement of construction of the projected high-speed transit line over the bridge until revenues from the bridge reached $4,000,000 annually. The cost of the high speed line with its connection to the rapid transit system in Philadelphia is estimated at about $8,000,000. For the fiscal year ended June 30 the net revenue of the bridge was approximately $2,900,000.

Flood Control and Harbor Work Funds Allotted

Allotment of funds made available for flood control and for river and harbor work under the Emergency Relief and Construction Act were announced by the War Department on Sept 13. The flood control allotments are as follows:

Levee construction:	
Memphis District	$6,500,000
Vicksburg District	1,500,000
New Orleans District	3,500,000
Bank protection, contraction works and dredging	3,950,000
Contingencies	50,000
Total	$15,500,000

Of the $30,000,000 provided for river and harbor work the Secretary of War has approved of the allotment of the amounts shown in the following table. An amount of $3,922,740 is unassigned.

ALLOTMENT OF RIVER AND HARBOR FUNDS UNDER RELIEF ACT

Project	*Allotment*
Thames River, Conn	$152,100
Bridgeport Harbor, Conn	209,000
New Bedford and Fairhaven Harbor, Mass	103,000
Hudson River, N. Y	185,000
East Chester Creek, N. Y	150,000
Mamaroneck Harbor, N. Y	21,600
Westchester Creek, N. Y	33,600
Manasquan River, N. J	62,460
Delaware River, Philadelphia to the Sea	960,000
St. Jones River, Del	25,200
Baltimore Harbor and Channels, Md	461,000
James River, Va	600,000
Intracoastal Waterway, Jacksonville to Miami, Fla	400,000
Tampa Harbor, Fla	233,550
Miami River, Fla. (Dinner Key)	108,000
Mobile Harbor, Ala	103,500
Louisiana-Texas Intracoastal Waterway (New Orleans-Sabine River Section)	108,000
Allegheny River, Pa., lock and dam construction	4,000,000
Kanawha River, W. Va	2,000,000
Mississippi River between Ohio and Illinois Rivers	2,000,000
Mississippi River between Illinois River and Minneapolis	3,200,000
Missouri River, Kansas City to the mouth	1,700,000
Missouri River, Kansas City to Sioux City	5,000,000
Tennessee River	1,500,000
Grand Haven Harbor and Grand River, Mich	25,650
Ashtabula Harbor, Ohio	30,000
Lorain Harbor, Ohio	87,000
St. Marys River, Mich	41,000
Monroe Harbor, Mich	600,000
Hoquiam River, Wash	49,500
Umpqua River, Ore	450,000
Columbia and Lower Willamette Rivers below Vancouver, Wash., and Portland, Ore	150,000
Willamette River above Portland and Yamhill River, Ore	189,000
San Joaquin River, Calif	138,600
Petaluma Creek, Calif	166,500
San Diego Harbor, Calif	134,000
Los Angeles and Long Beach Harbors, Calif	700,000
Total	$26,077,260

Steel Men Join Congress of Highway Engineers and Builders

The list of organizations participating in the Highway and Building Congress to be held in Detroit Jan. 16-20 has been increased by the addition of the Steel Founders Society of America and the American Institute of Steel Construction. As noted last week, twelve organizations already have signified their intention of taking part in the congress.

The American Institute of Steel Construction had tentatively scheduled its meeting to be held in October.

Canadian Highway Engineers Meet in Digby, Nova Scotia

Many engineers took part in the 19th annual convention of the Canadian Good Roads Association held in Digby, Nova Scotia, Sept. 12-14.

The extensive studies of soil mechanics now being conducted in the United States were brought to the attention of the association by R. D. French, Professor of Highway and Municipal Engineering of McGill University, Montreal. Professor French said that a road was only as good as its subgrade and that highway engineers should take advantage of the new information on subgrade problems being developed in the soil research now in progress.

Progress made in the application of mechanical equipment to highway construction was reviewed by Herbert T. Routly, Routly Construction Co., Toronto. Mr. Routly urged the substitution of employment on public works for direct relief.

Larger contributions by the cities for the construction of rural roads was urged by T. H. Mahony, chairman, Ontario Highway Advisory Board. He expressed the belief that the larger centers of population receive a considerable benefit from the construction of improved rural roads. Uniformity in highway signs and markings was urged upon the convention by William S. Canning of Philadelphia.

Hearings on Water Extension for New York City Set

Hearings on the application of the city of New York to extend its water supply system to include more of the subsurface sources in Nassau County on Long Island, N. Y., are to be held by the Water Power Control Commission of the state Sept. 26-28 at Freeport, L. I.

SOCIETY CALENDAR

AMERICAN ASSOCIATION OF ENGINEERS, annual convention, Washington, D. C., Sept. 26-28.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual meeting, Washington, D. C., Nov. 14-18.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, annual meeting, Detroit, Mich., Jan. 16-19, 1933, in connection with the Highway and Building Congress.

AMERICAN PUBLIC HEALTH ASSOCIATION, annual meeting, Washington, D. C., Oct. 24-27.

AMERICAN SOCIETY OF CIVIL ENGINEERS, fall meeting, Atlantic City, N. J., Oct. 5-8.

AMERICAN SOCIETY OF MUNICIPAL ENGINEERS, annual meeting, Detroit, Mich., Jan. 16-20.

AMERICAN WELDING SOCIETY, fall meeting, Oct. 3-7, Buffalo, N. Y.

ASPHALT INSTITUTE, Asphalt Paving Conference, New Orleans, La., Dec. 5-9.

HIGHWAY AND BUILDING CONGRESS participated in by fourteen national engineering societies and trade associations, Detroit, Mich., Jan. 16-20.

INTERNATIONAL CITY MANAGERS ASSOCIATION and GOVERNMENTAL RESEARCH ASSOCIATION will hold a joint annual conference at Cincinnati, Ohio, on October 24 to 26.

NATIONAL ASSOCIATION OF RAILROAD AND UTILITIES COMMISSIONERS, annual meeting, Hot Springs, Ark., Nov. 15-18.

NATIONAL COUNCIL OF STATE BOARDS OF ENGINEERING EXAMINERS, annual meeting, New York City, Sept. 29-Oct. 1.

NATIONAL SAFETY COUNCIL, annual congress, Washington, D. C., Oct. 3-7.

NEW ENGLAND WATER WORKS ASSOCIATION, annual meeting, Springfield, Mass., September 27-30.

NEW YORK STATE SEWAGE WORKS ASSOCIATION will hold its fall meeting at Saranac Lake Oct. 14-15.

NATIONAL PAVING BRICK ASSOCIATION will hold its 27th annual meeting in Detroit, Mich., Jan. 17-18, in connection with the Highway and Building Congress.

VIRGINIA WATER & SEWAGE WORKS ASSOCIATION will hold its fourth annual meeting at Staunton, Va., Nov. 14-15. H. W. Snidow, State Office Building Richmond, Va., is secretary.

OHIO CONFERENCE ON WATER PURIFICATION will be held Oct. 11 and 12 in Warren, Ohio. On the schedule are discussions of recent problems in water purification, elimination of tastes and odors, new bacteriological methods and an inspection of the new purification plant of the Mahoning Valley Sanitary District serving Niles and Youngstown.

OHIO CONFERENCE ON SEWAGE TREATMENT will be held Oct. 13 and 14 at Columbus. Papers scheduled include Minute Forms of Stream Life by W. C. Purdy, U. S. Public Health Service; Gas Hazards by R. R. Sayers, chief surgeon, U. S. Bureau of Mines. This deals with gas hazards incident to sewage plant operation. Round table discussions relating to plant operation will occupy one full session and the extensive sewerage improvement for Columbus now under way will be inspected.

Engineers to Make Survey for R.F.C. Loan Project in Virginia

Governor Pollard of Virginia has appointed a committee, headed by Allen J. Saville of Richmond, to make a tour of the state going into every city and county to determine what projects can be put forward as candidates for loans from the Reconstruction Finance Corp. under the Emergency Relief and Construction Act. The governor believes that at least $30,000,000 of work can be found in the state that will come within the self-liquidating requirements of the relief act.

Personal Notes

GERARD H. MATTHES, for the past three years principal engineer and chief of the hydraulic division in the U. S. Engineer Office, Norfolk, Va., has been transferred to Vicksburg, Miss., where he will be principal engineer in the office of the president, Mississippi River Commission.

HUGH L. COOPER, consulting engineer, New York, is to be awarded the Order of the Red Star, the highest decoration bestowed by the Russian Soviet Government, according to an announcement made on Aug. 26 when the government formally accepted the Dnieprostroy power project. The project was carried out under Col. Cooper's direction. It is stated that Col. Cooper is the first foreigner to receive this decoration.

WALLACE B. BOGGS, Oakland, has been appointed chief engineer of the highway district formed to construct the highway tunnel which will provide a new outlet through the hills east of Oakland and Berkeley, Calif. Mr. Boggs succeeds the late George Posey in this position. He was principal assistant to Mr. Posey from 1919 to 1931 when he resigned to enter private practice.

RANSOME ROGERS, assistant county highway engineer of Fulton County, Georgia, has been appointed highway engineer of the county to succeed the late H. N. HURT. Atlanta is located in Fulton County. E. E. YANTIS engineer, Board of Public Works, has been promoted to assistant highway engineer to succeed Mr. Rogers.

FRANK J. OLIVER, JR., has been appointed industrial co-ordinator of the College of Engineering, University of Detroit. Mr. Oliver's work will include placement of students from the civil and architectural engineering courses in work involving construction and drafting experience with firms cooperating with the university by giving practical work to the students. Mr. Oliver formerly was western editor of *American Machinist* and *Product Engineering*.

Obituary

ROY MOCERI, member of the contracting firm of Moceri Brothers, Seattle, was instantly killed Sept. 10, when he was knocked down and run over by one of his loaded gravel trucks near Auburn, Wash., as the truck was backing down a grade. Mr. Moceri was 47 years old.

Contracts and Capital

CONSTRUCTION
(Thousands of Dollars)

	Weekly Average Sept. 1931	Weekly Average Sept. 1932	Week Sept. 22 1932
Federal government.	$10,409	$4,963	$2,716
State and municipal.	21,880	15,143	17,622
Total public.....	$32,289	$20,106	$20,338
Total private.....	11,950	2,731	3,995
Week's total.....	$44,239	$22,837	$24,333
Cumulative, Jan. 1 to date:			
1931 construction.....			$1,929,722
1932.....			891,555

Decrease, 54 per cent.

NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

	Weekly Average Sept. 1931	Weekly Average Sept. 1932	Week Sept. 17 1932
Total private and public.....	$45,500	$17,600	$24,000
Cumulative, Jan. 1 to date:			
1931 new capital.....			$1,851,500
1932 new capital.....			646,000

Decrease 65 per cent.

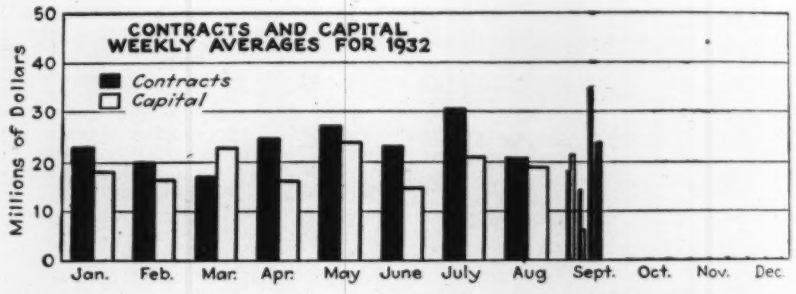
ENR Cost and Volume Index

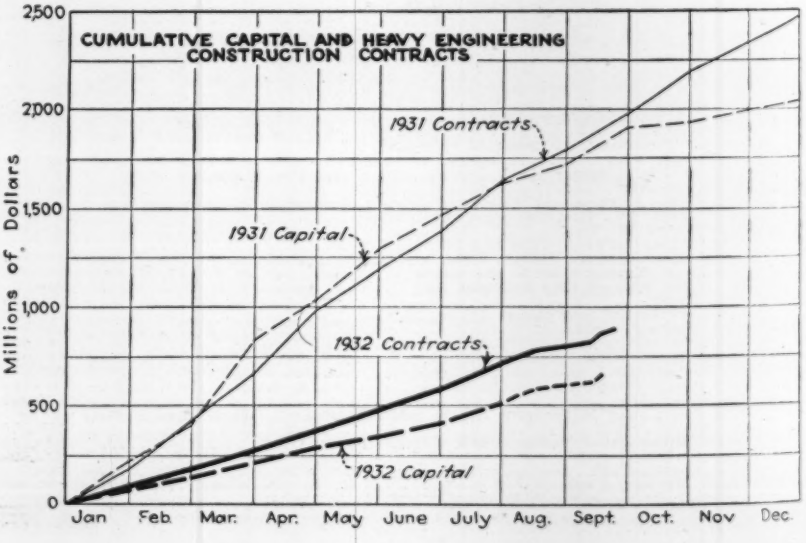
Cost		Volume	
September, 1932	157.96	**August, 1932**...	111
August, 1932.....	156.80	July, 1932.....	166
September, 1931..	171.40	August, 1932....	187
1931 (Average)...	181.35	1931 (Average)..	220
1930 (Average)...	202.85	1930 (Average)..	260
1913 Average.....	100.00		

Engineering Contracts and Capital

CONTINUED heavy awards for highway construction boosted the week's engineering construction contract total to $24,333,000, of which $14,500,000 was for road work. This is the second consecutive high week for highway awards, the previous week's total being $16,000,000. Federal contracts were unusually low, amounting to $2,716,000. Private awards were above the average, totaling 4 millions. Heavy highway contracts let during the week included Missouri, $1,251,000; New York, $3,579,000; West Virginia, $1,195,000; and Louisiana, $904,000. Funds for most of these awards are coming from loans made under the provisions of the emergency relief and construction act. Another section of the Louisville, Ky., outfall sewer was let for $790,000.

New capital for construction purposes reached 24 millions. Boston floated a bond issue of over 5 millions for public improvements. Private capital issues amounted to 9 millions. Included in this amount is $3,850,000 for the Dotsero cutoff of the D. & R. G. W. R.R., granted as a loan by the R.F.C. Work on the 42-mile cutoff will commence shortly.

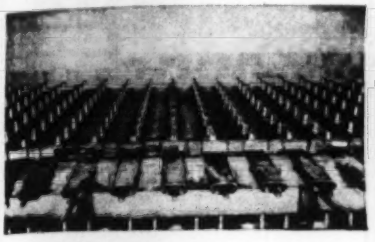


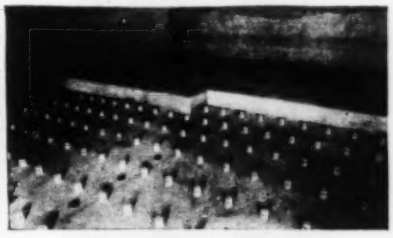


Waterworks Equipment and Materials

No Metal in New Filter Bottom

A concrete duplex filter bottom is being manufactured by the F. B. Leopold Co., Inc., Pittsburgh, Pa. The system is built of concrete material throughout with porcelain nozzles. There are no materials in





Leopold duplex filter bottom.

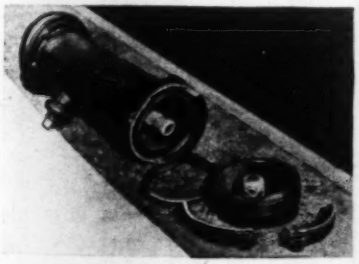
contact with the water that are subject to corrosion.

The underdrain system consists of a primary system comprising a concrete header flume and concrete laterals, in the top of which are cast glazed porcelain nozzles. The laterals are cast 12 in. apart and the nozzles are set 8 in. apart. On top of this primary system are placed precast concrete blocks, 12 in. wide and 24 in. long. The blocks have corrugated tops and are perforated with small holes in the tops of the corrugations. The manufacturer states that only 6 in. of filter gravel, with a maximum size of ¾ in., is necessary.

New Hydrant Quickly Repaired

A new type of fire hydrant capable of quick replacement if broken by collision from automobiles, has been developed by the Kennedy Valve Manufacturing Co., Elmira, N. Y. The design of the new hydrant is such that water pressure need not be shut off while awaiting or making replacements.

The distinguishing feature of the so-called Safetop fire hydrant is a breakable section of the barrel located a few inches above the ground line. Both the standpipe and



A collision by an automobile will damage the new Kennedy Hydrant only at one point.

the stem of the hydrant are in two parts which join at this point, being held together by a threaded "breaking ring." The upper and lower portions of the stem are similarly held by a coupling secured to each portion by a large pin. Grooves in the breaking ring and stem coupling localize the break resulting from a collision. The breaking ring and coupling are the only parts that need replacement following damage. As the water pressure in the main keeps the inlet valve tightly closed, there is no danger of flooding.

Mechanical Mixing Device Recirculates Sludge

A mechanical chemical mixing device for water purification plants known as a Flocculator, has been introduced by the Dorr Co., New York, N. Y. It consists of a number of large-radius paddles rotating about a horizontal axis. In existing water plants using a number of rectangular sedimentation basins the flocculators are installed transversely across the influent end of the tanks. In a new plant or one where mechanically cleaned basins are used, the flocculators may be in separate tanks.

The paddle blades are of paraffined wood, attached to the ends of radial steel arms, and are supplemented by diagonal blades to prevent the formation of dead zones around the shaft. The shaft is supported between paddles by bearings resting upon concrete or steel columns and is driven by a variable-speed motor and speed reducer. Each paddle wheel assembly is oriented 90 degrees out of phase with adjacent units to minimize surging and to give better dynamical balance. When a number of flocculators are used, the water passes through them in series, the shafts being arranged parallel to one another and rotating in unison. In this case the paddle blades are so arranged as to provide a progressive diminution in the intensity of agitation. The direction of rotation is such that the paddles draw back into the mixing zone some of the sludge deposited on the bottom of the sedimentation tank. The purpose of this action is to improve flocculation and decrease the amount of chemical coagulant required.

The Dorr Co.'s Flocculator, a mechanical mixing device for water plants.

New Equipment in Brief

Speed Reducer. A new motorized speed reducer has been added to the line of inclosed speed reducing units built by Link-Belt Co., Philadelphia, Pa. The reducer is a triple reduction unit with a speed ratio of 312.2 to 1. The motor shaft, extending into the reducer housing, operates at 1165 r.p.m., and the low speed shaft at 3.75 r.p.m. Roller bearings and continuous-tooth herringbone gears are used. The gears run in oil, providing automatic lubrication. Thirty-two of the new units have been made for driving the sludge collectors at New York's new sewage plant.

Fire Hydrant. A new compression fire hydrant which allows all internal working parts to be removed without digging up the hydrant or disturbing the main connection, is announced by the Chapman Valve Manufacturing Co., Indian Orchard, Mass. The hydrant opens against the line pressure and closes with the pressure. It is so designed that in case the post or barrel is broken by sudden impact, or gradual pressure is applied sufficient to break or crack it, thereby relieving the tension of the operating screw and rod with the hydrant seat, the water pressure will hold the valve to its seat and no flooding can result. The operating rod is used as a wrench to unseat the hydrant for removing working parts. The under side of the flanged connection between the barrel and the body is 2 in. above the ground line.

Business Notes

WORTHINGTON PUMP & MACHINERY CORP., Harrison, N. J., announces that an arrangement has been made for the joint use of the manufacturing, engineering, sales and service facilities of the Meter Division of the Worthington Pump & Machinery Corp. and those of the Gamon Meter Co., whose plant is located at Newark, N. J. The sales staffs of both organizations will report to George H. Gleeson, who will direct the meter sales activities of both companies.

THE SUPERHEATER CO., 60 East 42d St., New York, N. Y., announces that M. Schiller, in addition to his duties as vice-president, has been elected treasurer of that company, to succeed W. F. Jetter, recently resigned.

PENNSYLVANIA-DIXIE CEMENT CORP., announces the appointment of Dan R. Long to the position of district sales manager, in charge of activities in metropolitan and suburban New York, northern New Jersey and western Connecticut, with headquarters in the Lincoln Building, 60 East 42d St., New York, N. Y.

Current Construction Unit Prices

Wood Pole Line Electric Distribution System, Piqua, Ohio

CONTRACTS for a new electric distribution system have been let by the city of Piqua, Ohio. Alternates were taken on two types of wood poles, butt-treated western red cedar and creosoted yellow pine, contract being let on the basis of using the red cedar poles. Two contracts were let for the system, one, covering the pole line installation, being awarded to Monroe Electric Co., Chicago, for $190,199; the other, covering manhole, conduit and cable installation, being awarded to J. F. Pritchard & Co.,,Kansas City. Burns & McDonnell Engineering Co., Kansas City. is consulting engineer. Following are complete unit prices of the two successful bidders.

Item	Unit Prices — Monroe Electric Co. Mat.	Labor	Total	J. F. Pritchard & Co. Mat.	Labor	Total
Western Red Cedar Poles Butt Treated in Place						
25′ class 3	$6.52	$3.75	$10.27	$8.15	$2.10	$10.25
25′ class 4	5.63	3.75	9.48	6.65	2.10	8.75
25′ class 5	4.98	3.75	8.73	5.50	2.10	7.60
30′ class 3	8.97	3.94	12.91	9.55	2.10	11.65
30′ class 4	7.99	3.94	11.93	8.55	2.10	10.65
30′ class 5	7.03	3.94	10.97	7.00	2.10	9.10
35′ class 2	13.68	4.57	18.25	13.35	2.10	15.45
35′ class 3	12.61	4.57	17.18	11.70	2.10	15.80
35′ class 4	11.18	4.57	15.75	10.70	2.10	12.80
40′ class 2	16.05	5.13	21.18	16.00	2.10	18.10
40′ class 3	14.97	5.13	20.10	14.00	2.10	16.10
40′ class 4	13.58	5.13	18.71	12.45	2.10	14.55
45′ class 2	19.11	5.75	24.86	19.00	2.10	21.10
45′ class 3	.....	.....	.....	16.55	2.20	18.75
50′ class 2	22.40	5.75	28.15	21.90	2.25	24.15
50′ class 3	20.24	5.75	25.99	18.80	2.30	21.10
55′ class 2	24.39	6.50	30.89	28.00	2.42	30.42
60′ class 2	26.50	7.50	34.00	27.20	2.42	29.62
Transformer structure	27.50	46.69	74.50	24.00	16.00	40.00
Creo. Yel. Pine Poles in Place						
25′ class 3	6.42	3.75	10.17	6.21	2.10	8.51
25′ class 4	5.36	3.75	9.11	5.66	2.10	7.76
25′ class 5	4.64	3.75	8.39	4.72	2.10	6.82
30′ class 3	9.11	3.94	13.05	9.05	2.10	11.15
30′ class 4	7.66	3.94	11.60	7.25	2.10	9.35
30′ class 5	7.02	3.94	10.96	6.45	2.10	8.55
35′ class 2	11.80	4.57	16.37	12.26	2.10	14.36
35′ class 3	11.79	4.57	16.36	11.90	2.10	14.00
35′ class 4	9.48	4.57	14.05	9.85	2.20	12.05
40′ class 2	17.69	5.13	22.82	16.00	2.20	18.20
40′ class 3	15.84	5.13	20.97	14.70	2.20	16.90
40′ class 4	12.80	5.13	17.93	11.55	2.20	13.75
45′ class 2	22.26	5.75	28.01	18.70	2.20	20.90
45′ class 3	18.85	5.75	24.60	15.91	2.20	18.11
50′ class 2	25.37	5.75	31.12	23.00	3.15	26.15
50′ class 3	21.86	5.75	27.61	18.53	3.15	21.68
55′ class 2	30.32	6.50	36.82	24.29	3.50	27.79
60′ class 2	34.65	7.50	42.15	27.20	3.75	30.95
Cross Arms in Place Incl. Hardware						
2 pin single	.75	.56	1.31	.64	.60	1.24
2 pin double	1.82	1.19	3.01	1.50	1.15	2.65
4 pin single	.96	.68	1.65	.85	.60	1.45
4 pin double	2.35	1.38	3.73	1.92	1.20	2.12
6 pin single	1.17	.82	1.99	.99	.60	1.59
6 pin double	2.62	1.63	4.25	2.19	1.20	3.39
8 pin single	1.35	1.05	2.40	1.13	.60	1.73
8 pin double	3.00	1.88	4.88	2.47	1.20	3.67
4 pin alley arm single	2.19	.98	3.17	1.56	.75	2.31
4 pin alley arm double	3.75	2.13	5.88	3.30	1.50	4.80
6 pin alley arm single	2.25	2.13	4.38	1.71	.75	2.46
6 pin alley arm double	4.63	2.25	6.88	3.45	1.50	4.95
Secondary Racks Installed						
3 wire (light type)	.77	.34	1.11	.81	.47	1.28
3 wire (heavy type)	1.13	.34	1.47	1.32	.47	1.79
4 wire (light type)	.94	.34	1.28	1.02	.47	1.49
4 wire (heavy type)	1.69	.34	2.03	1.68	.47	2.15
Guys and Anchors Installed						
¼″ head guy	3.74	.67	4.40	3.79	2.00	5.79
⅜″ head guy	5.06	.67	5.73	2.78	1.75	4.53
¼″ arm guy	2.53	.67	3.20	2.00	1.58	3.58
¼″ down guy	3.36	.94	4.30	3.42	1.25	4.67
⅜″ down guy	2.09	.87	2.96	2.90	1.16	4.06
½″ down guy	1.87	.67	2.54	2.37	1.10	3.47
⅝″ ecrulux anchors	2.48	2.67	5.15	2.10	.85	2.95
8″ x 20″ nevercreep anchors	3.36	5.34	8.70	2.24	1.10	3.34
Arresters and Grounds Installed						
Ground	1.66	.94	2.60	1.75	1.00	2.75
6,600 v. lightning arrester	12.00	.94	12.94	10.05	.44	10.49
2,300 v. lightning arrester	5.45	.94	6.39	3.86	.44	4.30
Neutral lightning arrester	1.10	.94	2.04	1.05	.44	1.49
Pins and Insulators in Place						
Steel pole top pin	.13	.14	.27	.125	.06	.185
Steel pin	.17	.07	.24	.155	.04	.195
Glass insulator	.06	.03	.09	.067	.03	.097
Strain insulator	1.60	.34	1.94	1.65	.04	1.69
Loop insulator	.39	.07	.46	.32	.02	.34

Item	Unit Prices — Monroe Electric Co. Mat.	Labor	Total	J. F. Pritchard & Co. Mat.	Labor	Total
Cutouts Installed						
60 amp 2,300 v. expul. type	4.30	.94	5.24	3.86	.55	4.41
150 amp. 2,300 v. expul. type	4.73	.94	5.67	3.96	.55	4.51
Cop. Wire in Place—Per M.Ft.						
4/0 T.B.W.P	79.76	47.50	127.26	84.50	35.20	119.70
2/0 T.B.W.P	52.87	31.25	84.12	56.50	22.90	79.40
1/0 T.B.W.P	42.87	25.00	67.87	46.00	18.60	64.60
2 T.B.W.P	27.11	16.25	43.36	25.74	11.00	36.74
4 T.B.W.P	17.43	10.36	27.79	17.40	9.00	26.40
6 T.B.WP	12.25	6.25	18.50	12.20	9.00	21.20
6 Tree Wire	68.00	37.00	105.00	42.80	12.00	54.80
Transfor. Compl. Connected						
1½ K.V.A. 2,300-115/230 v	25.64	4.00	29.64	27.89	4.50	32.39
3 K.V.A. 2,300-115/230 v	37.89	6.66	44.55	40.53	4.50	45.03
5 K.V.A. 2,300-115/230 v	48.48	8.00	56.48	54.21	4.50	58.71
7½ K.V.A. 2,300-115/230 v	65.16	10.00	75.16	71.06	4.50	75.56
10 K.V.A. 2,300-115/230 v	79.11	13.33	82.44	86.32	4.50	90.82
15 K.V.A. 2,300-115/230 v	105.76	16.67	122.43	114.75	4.50	119.25
25 K.V.A. 2,300-115/230 v	151.85	26.00	177.85	166.00	4.50	170.50
37½ K.V.A. 2,300-115/230 v.	201.75	23.37	225.12	223.19	.....	.....
50 K.V.A. 2,300-115/230 v	246.89	26.66	273.55	272.28	.....	.....
75 K.V.A. 2,300-115/230 v	.....	.....	.....	.....	.....	.....
100 K.V.A. 2,300-115/230 v.	.....	.....	.....	410.72	.....	.....
200 K.V.A. 2,300-115/230 v.	.....	.....	.....	602.99	.....	.....
25 K.V.A. 4,000-115/230 v	.....	.....	.....	.....	.....	.....
Customers' Services Complete						
2 wire No. 8 serv. installed	1.43	3.60	5.03	1.87	55.00	56.87
2 wire No. 6 serv. installed	1.99	3.60	5.59	2.62	.84	3.46
3 wire No. 8 serv. installed	2.50	4.20	6.70	2.00	.84	2.84
3 wire No. 6 serv. installed	3.42	4.20	7.62	3.73	.84	4.57
3 wire No. 2 serv. installed	7.09	5.40	12.49	5.85	.84	6.69
3 wire No. 0 serv. installed	11.02	8.40	19.42	5.15	1.75	6.90
3 wire No. 4/0 serv. installed	26.40	12.00	38.40	11.10	1.75	12.85
4 wire No. 8 serv. installed	3.42	5.40	8.82	3.05	.94	3.99
4 wire No. 6 serv. installed	4.13	5.40	9.53	3.40	.94	4.34
4 wire No. 2 serv. installed	8.62	6.00	14.62	7.30	.94	8.24
Watthour Meters Installed						
2 wire 5A. s. ph. 115 v	7.21	.30	7.51	7.18	.60	7.68
2 wire 10A. s. p. 115 v	7.60	.60	8.20	7.58	.60	8.28
2 wire 15A. s. p. 115 v	8.06	.60	8.66	8.00	.60	8.60
2 wire 25A. s. p. 115 v	10.60	.72	11.32	10.52	.60	11.12
3 wire 5A. s. p. 115/230 v	8.08	.60	8.68	8.00	.65	8.65
3 wire 10A. s. p. 115/230 v	8.44	.66	9.10	8.40	.65	9.05
3 wire 15A. s. p. 115/230 v	9.01	.72	9.73	8.93	.65	9.58
3 wire 25A. s. p. 155/230 v	11.78	.84	12.62	11.78	.65	12.43
3 wire 50A. s. p. 115/230 v	16.68	.84	17.52	16.41	.65	17.06
3 wire 5A. 3 p. 220 v	25.00	.84	25.84	24.62	.84	25.46
3 wire 10A. 3 p. 220 v	26.69	.84	27.53	26.63	.84	27.47
3 wire 15A. 3 p. 220 v	28.11	.90	29.01	27.54	.84	28.38
3 wire 25A. 3 p. 220 v	29.86	1.20	31.06	29.91	.84	30.75
3 wire 50A. 3 p. 220 v	33.76	1.80	35.56	33.56	.84	34.40
4 wire 10A. 3 p. 115 v	36.05	.84	36.89	35.75	1.10	36.85
4 wire 15A. 3 p. 115 v	37.98	.84	38.82	36.84	1.10	37.94
4 wire 25A. 3 p. 115 v	40.72	1.00	41.72	40.67	1.10	41.87
4 wire 50A. 3 p. 115 v	45.91	1.80	47.71	45.96	1.10	47.06
Cond. Lines in Pl.—per Lin.Ft.						
2 way conduit line	.44	.27	.71	.45	.21	.66
4 way conduit line	.83	.47	1.30	.695	.25	.945
6 way conduit line	1.16	.74	1.90	.97	.32	1.29
Manholes Complete in Place						
Two way manhole	275.00	266.67	541.67	70.00	38.00	108.00
Three way manhole	286.00	300.00	586.00	76.00	42.00	118.00
Terminal pole comp. in place	39.00	16.67	55.67	61.90	27.00	88.90
Paving remov. and repl., sq.yd.	.30	.35	.65	1.47	1.20	2.67
Sidewalk remov. and repl., sq.ft.	.17	.20	.37	.40	.80	1.20
Excavation in trench, cu.yd	.....	3.00	3.00	.....	1.23	1.23
4″ sewer tile—per lin.ft	1.38	2.22	3.60	.11	.13	.24
No. 2, 5000 v. lead covered cable—per ft	.47	.07	.54	.44	.08	.52
Splices Complete in Place						
No. 2, 4 conductor, 5,000 v., str't splice	5.50	24.00	29.50	6.00	7.00	13.00
No. 2, 4 conductor, 5,000 v., br'ch splice	5.50	26.67	32.17	7.00	8.00	15,00
Pothead in Place	34.10	35.00	69.10	28.00	8.00	36.00
Fireproofing — per lin.ft	.33	.93	1.26	.60	.80	1.40
Cable racking stanchion	.62	.40	1.02	.60	.80	1.40
Cable hanger, single	.37	.14	.51	.35	.05	.40
Street Lighting Equipment Inst.						
16′ blvd. standard, top, cut-out, glass	68.47	14.00	82.47	75.13	1.10	76.23
13′ blvd. standard, top, cut-out, glass	65.00	14.00	79.00	71.13	1.10	72.23
Base transformer instead of cutout, add	27.50	15.00	42.50	22.74	.40	23.14
Refrac. for blvd. stand., add.	7.50	3.00	10.50	5.37	.10	5.47
Bracket type street light	14.57	2.80	17.37	16.75	.40	17.15
Telescopic brack. typ. st. lt.	16.00	3.00	19.00	19.50	.80	20.30
2″ fiber duct — per foot	.15	.46	.61	.121	.126	.247
No. 8, 5000 v. single cond. in conduit	.08	.03	.11	.081	.015	.096
No. 8, 5000 v. single cond. trenchlay	.075	.095	.17	.069	.09	.159
Pole type remote con. switch	84.00	21.00	105.00	69.00	12.00	81.00
Time switch with astronomic dial	31.94	21.00	52.94	9.50	.60	10.10
Single conductor pothead	4.20	3.50	7.70	12.00	6.00	18.00